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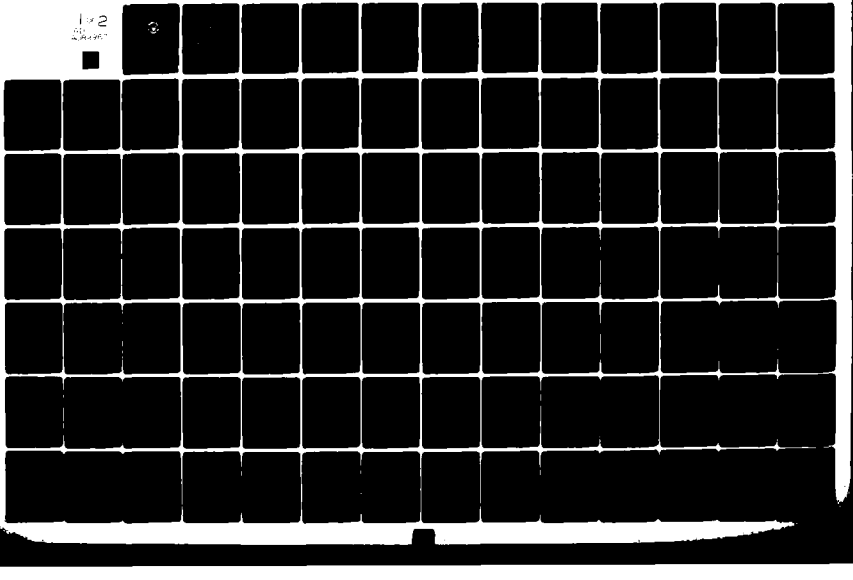

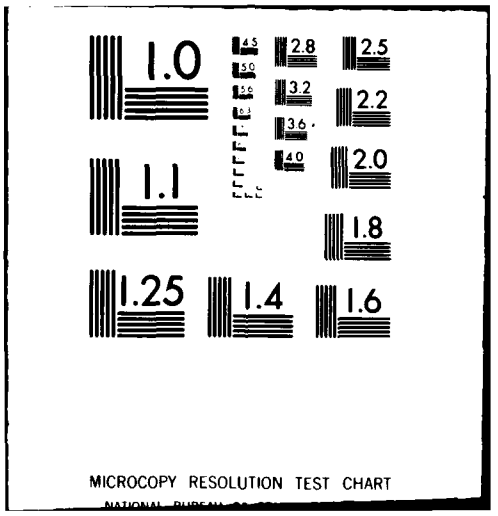
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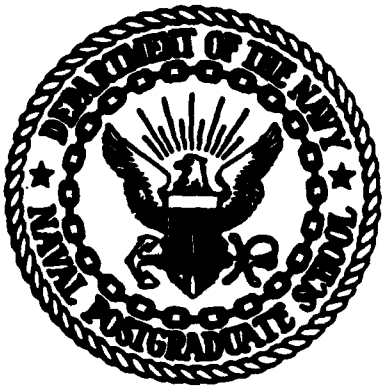

THESIS

An Accuracy Analysis of
The Army Materiel System Analysis Activity
Reliability Growth Model

by

Donald Paul Amiotte

June 1980

Thesis Advisor: W. M. Woods

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In this paper, a statistical model known as the AMSAA reliability growth model, is evaluated by measuring how well it tracks various reliability growth patterns. These patterns are defined by specified sequences of failure rates. Monte Carlo simulation is used to generate test data based on a time-terminated test plan. Estimates of failure rates, computed using the AMSAA model, are compared with the specified failure rates. Results for 18 reliability growth

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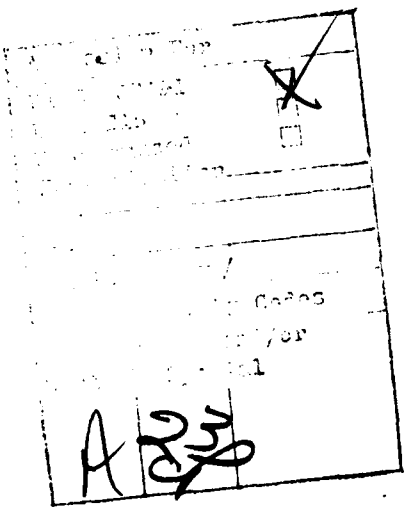

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An Accuracy Analysis of The Army Materiel System Analysis Activity Reliability Growth Model

by

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Captain, United States Marine Corps
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Submitted in partial fulfillment of the requirements for the degree of

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from the

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ABSTRACT

In this paper, a statistical model known as the AMSAA reliability growth model, is evaluated by measuring how well it tracks various reliability growth patterns. These patterns are defined by specified sequences of failure rates. Monte Carlo simulation is used to generate test data based on a time-terminated test plan. Estimates of failure rates, computed using the AMSAA model, are compared with the specified failure rates. Results for 18 reliability growth patterns are presented in both tabular and graphical form. Four modifications in the use of the model are discussed with selected results of their application presented.

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LIST OF FIGURES

I. INTRODUCTION

Many methods of modeling reliability growth have been proposed and used with some success. Reference 1 contains a detailed discussion of reliability growth, reliability growth models, and describes several models that are available to the manager for use in measuring reliability growth in his program.

The purpose of this study is to evaluate the accuracy of the Army Materiel Systems Analysis Activity (AMSAA) reliability growth model [Ref. 1] for systems which provide limited test data during the development cycle.

II. THE AMSAA RELIABILITY GROWTH MODEL

The AMSAA reliability growth model is a statistical model that estimates reliability growth trends. It is applicable to systems for which usage data is measured on a continuous scale.

As with most reliability growth models, the AMSAA model uses test data to estimate unknown parameters which are then used to estimate the reliability growth trend. References 1 and 2 develop the AMSAA model in detail. This paper addresses the use of the AMSAA model for sequential, time-terminated testing.

Time-terminated testing occurs when each item is tested until failure or until that item has been tested a specified amount of time. If an item does not fail before the planned test time, then a failure has not occurred and the next item is tested.

For time-terminated testing, the AMSAA model [Ref. 1] provides the following estimate for the failure rate of a type of hardware unit (component, assembly, subsystem, system) at total accumulated test time T on that type of unit:

$$\hat{r} = \hat{\beta}\left(\frac{N}{T}\right) \quad ,$$

where N = number of failures of that type of item to time T

and

$$\hat{\beta} = \frac{N}{N \ln T - \sum_{j=1}^{N} \ln X_j}$$

with X_j = total accumulated test time over all items tested when the j th failure occurs.

Using these estimators, the accuracy of the AMSAA model was evaluated for a variety of reliability growth patterns.

III. TESTING PROCEDURE

Reliability growth models are often evaluated against actual test data. The problem with evaluating a model against actual data is that the failure rate driving the system at any one time is never known, it can only be estimated.

The purpose of this chapter is to describe the test plan under which the analysis was made and define the test organization used. Figure 1 shows the relationship between the elements of the test plan and the organization of the testing.

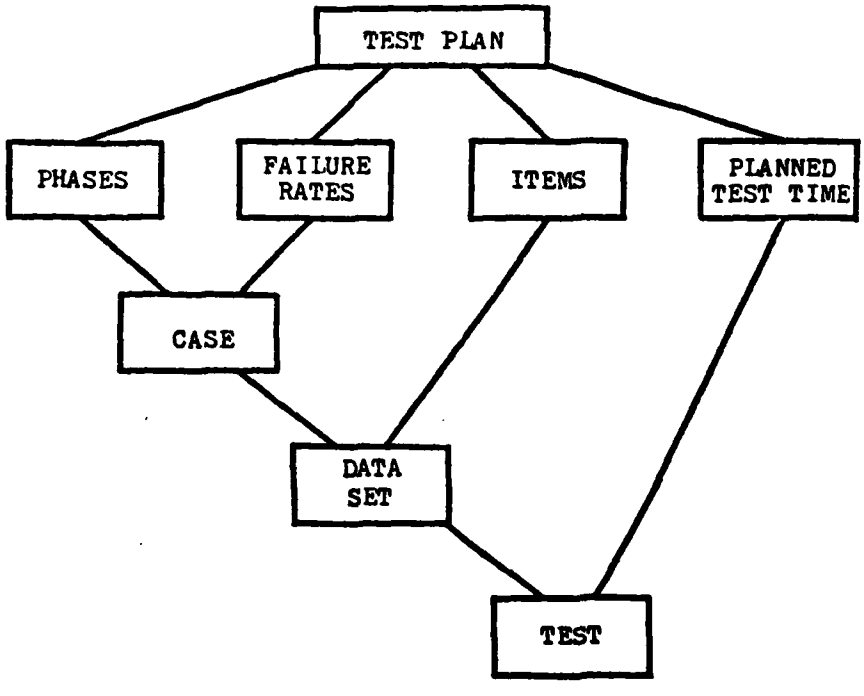


Figure 1. Test Organization

A. TEST PLAN

The key elements of the test plan used for the evaluation of the AMSAA model are described below.

1. Phases

Tests were conducted in phases consisting of testing a specified number of items with randomly generated exponential failure times based on the failure rate specified for that phase.

2. Failure Rates

Each phase had a specified failure rate, which was assumed to be constant for the duration of the phase. The failure rates specified could be different from phase to phase. This set of failure rates defined the reliability growth pattern for a test.

3. Items Tested

A specified number of items was tested in each phase. In this analysis, the number of items tested was the same for each phase in any one test.

4. Planned Test Time

Each item in a phase was tested to failure or until the specified planned test time for that phase was reached. The planned test time was the same for all items tested during any one phase.

B. TEST ORGANIZATION

1. Cases

The AMSAA model was applied to 18 test cases where each case was defined by a set of failure rates and a

specified number of phases. The general shape of the various cases, classified by number of phases and by trend of growth, can be found in Figures 2 through 5. Test phases are plotted, equally spaced, on the horizontal axis and failure rates are plotted on the vertical axis.

a. Set of Failure Rates

Each set of failure rates defined a reliability growth curve which was then classified by its general trend of growth into one of two categories:

(1) Non-increasing Failure Rates (Figures 2 and 3)

(2) Failure Rates that Increase at least once during testing (Figures 4 and 5)

b. Number of Phases

In addition to their growth trend, cases were grouped, for comparison, by their total number of phases. The two groups are those that have 16 phases and those that have 6 phases.

(1) 16-Phase Cases. Cases 1 through 6 (Figure 2) and cases 13 through 18 (Figure 5) were each defined by specifying 16 failure rates, one for each of the 16 test phases.

(2) 6-Phase Cases. The growth patterns for cases 7 through 12 (Figures 3 and 4) were defined by a set of six failure rates. Some of the cases reflect the same growth patterns shown for the 16-Phase cases, except that, the testing was carried out for only six test phases.

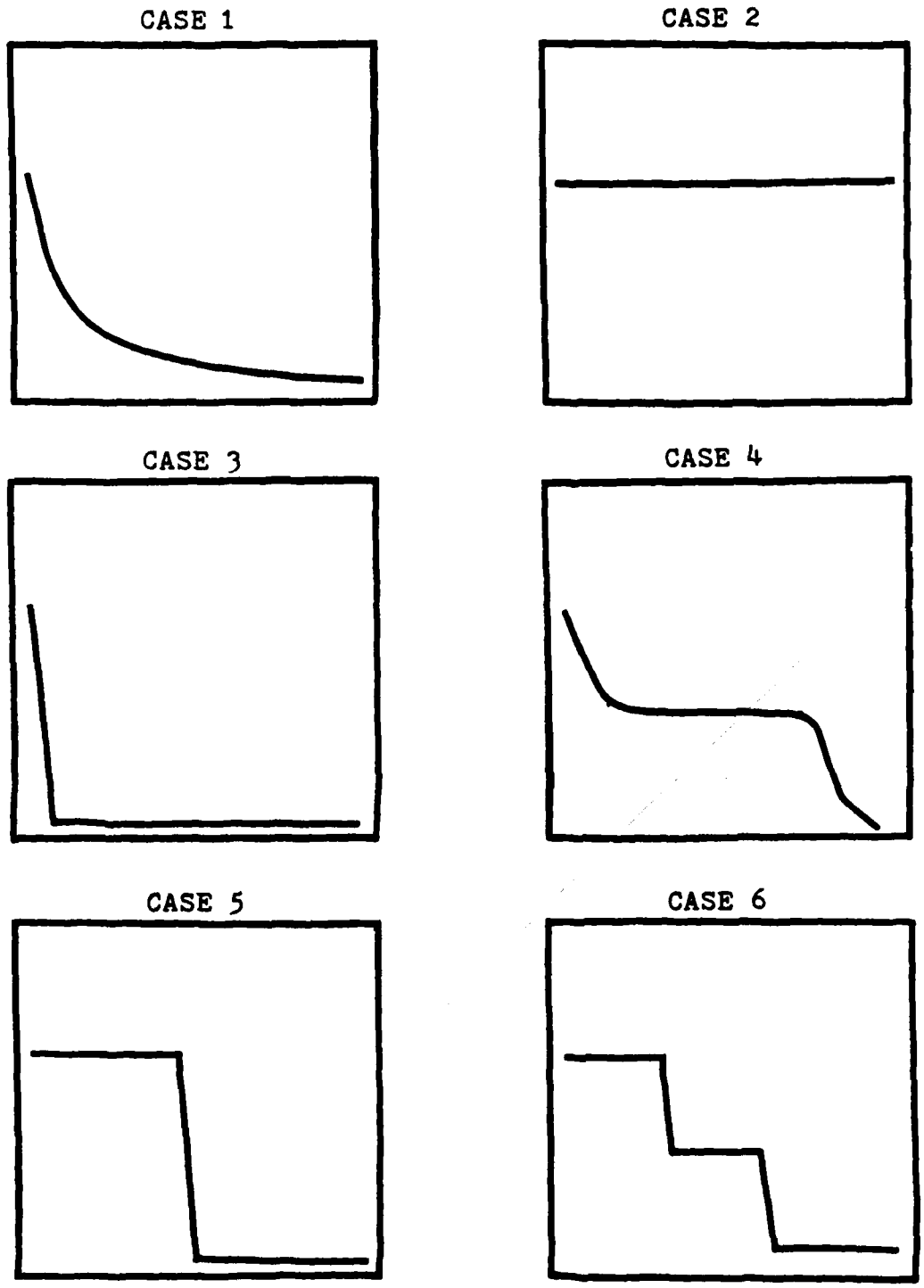


Figure 2. 16-Phase Cases with Non-increasing Failure Rates

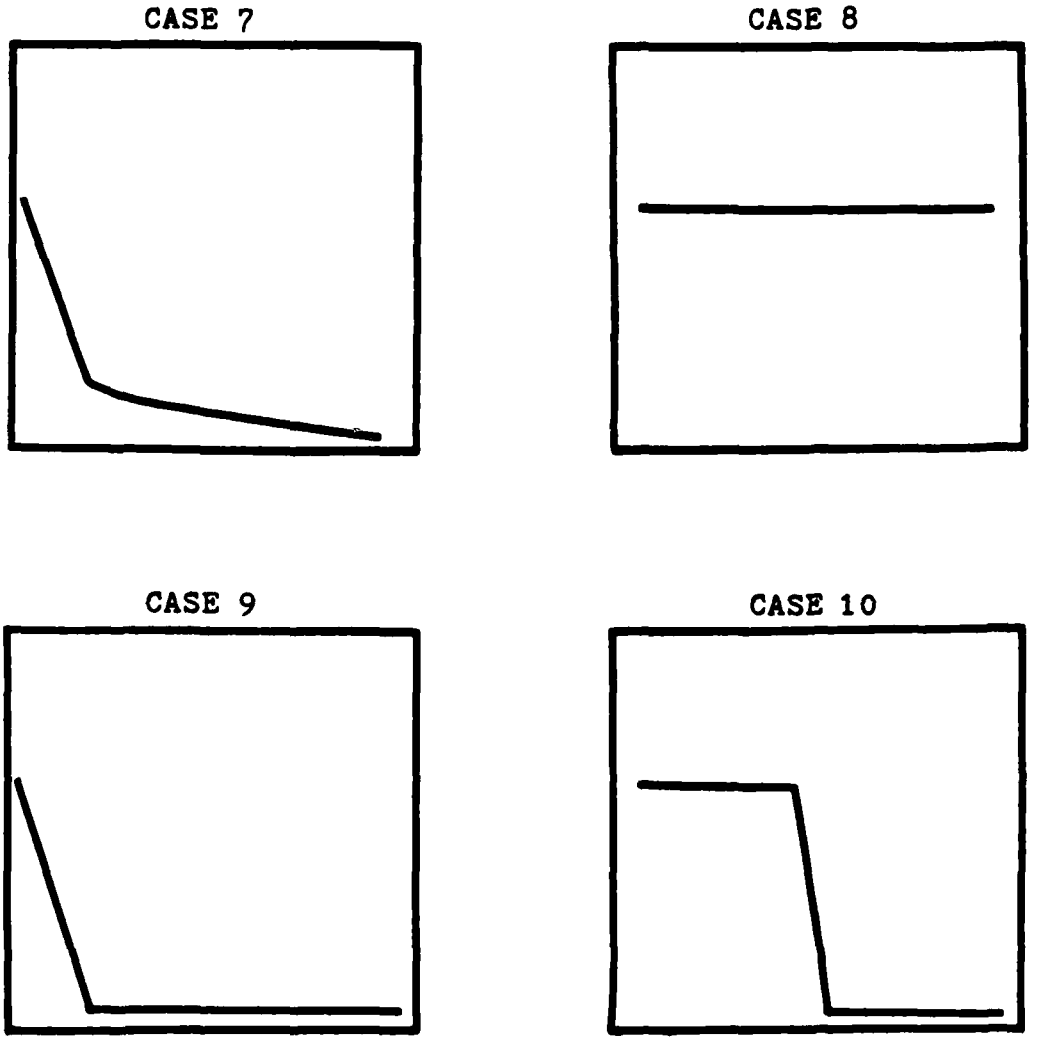
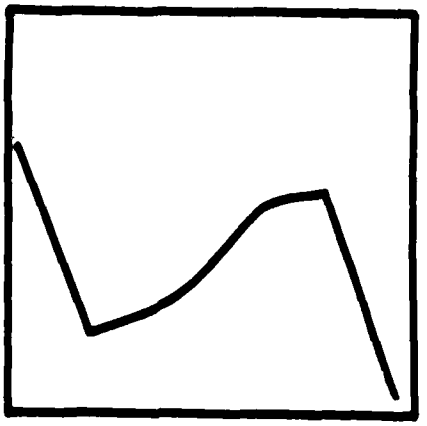


Figure 3. 6-Phase Cases with Non-increasing Failure Rates

CASE 11



CASE 12

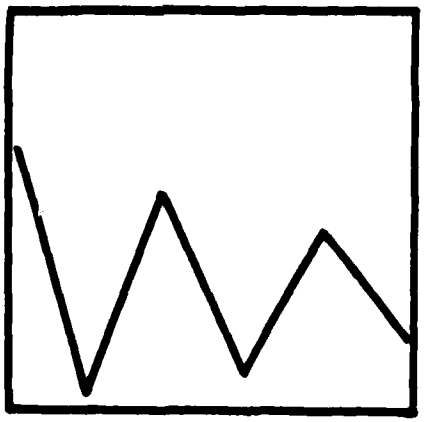


Figure 4. 6-Phase Cases with Failure Rates that Increase

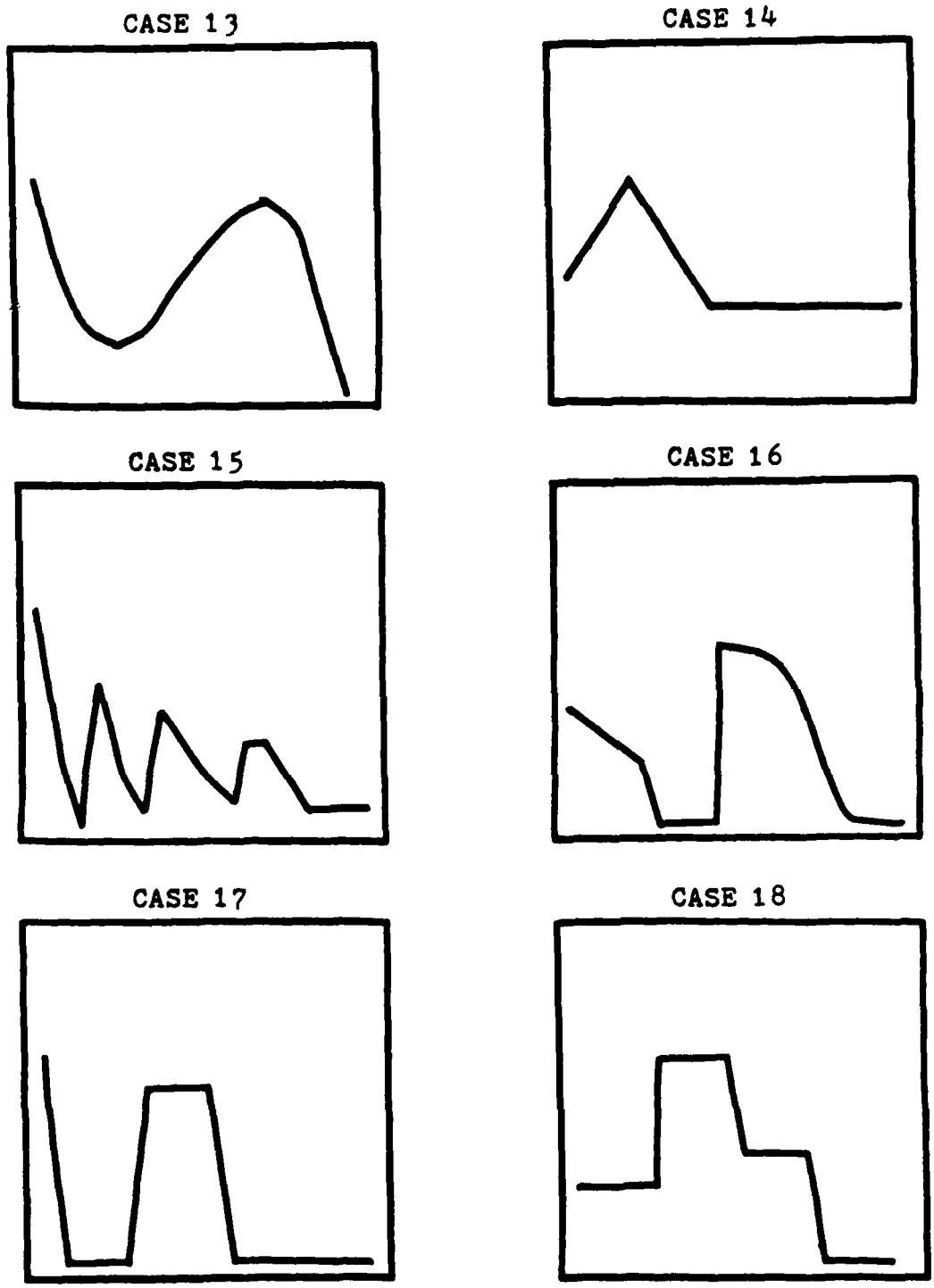


Figure 5. 16-Phase Cases with Failure Rates that Increase

2. Data Sets

Specification of the number of items to be tested in any phase for a particular case resulted in a Data Set. The number of items tested during a phase was the same for each phase of testing. Three sets of test data were generated for each case, one set each for tests with 5, 10, and 20 items per phase.

3. Tests

The remaining element of the test plan, Planned Test Time, was used to define individual tests. Since the failure rate underlying the exponential test times was known, planned test times were chosen so that the probability of survival was such that sufficient failures would occur.

a. Test 1

The planned test times for Test 1 were generated so that the probability of survival for each item would be .85.

b. Test 2

Test 2 consisted of generating planned test times by using a probability of survival for each item of .99. This test was run to see how the model performed with very limited data.

IV. ANALYSIS PROCEDURE

A. MODEL ESTIMATES

1. Shape Parameter

Using the test data generated above, the shape parameter for the model was estimated at the end of each phase, i, using the AMSAA estimator:

$$\hat{\beta}_i = \frac{N_i}{N_i \ln T_i - \sum_{j=i}^{N_i} \ln X_j} ,$$

where

N_i = number of failures that occurred to the end of phase i,

T_i = total accumulated test time over all items to the end of phase i,

and X_j = total accumulated test time over all items when the j th failure occurs

with a small exception.[1]

2. Failure Rate

The model estimate of the failure rate at the end of the i th phase was computed in accordance with the AMSAA model as follows:

---

[1] It should be noted that the estimate of β can only be computed when $N_i \geq 1$. If $N_i = 1$, the failure must not occur as the last item of a phase since, in that case, $T_i = X_i$, thus making $\hat{\beta}$ an indeterminate form.

$$\hat{r}_i = \hat{\beta}_i \left(\frac{N_i}{T_i} \right) .$$

This resulted in a set of failure rate estimates that was then compared to the set of specified failure rates used to generate the test data.

B. EVALUATION CRITERIA

The manager using a reliability growth model is interested in two things, accuracy and variability.

1. Accuracy

Accuracy measures the ability of the model to track a reliability growth trend. The measure of accuracy used in evaluating the AMSAA model was the failure rate estimate error as a percentage of the actual failure rate.

This percentage error is defined as follows:

$$e_i = \frac{|\bar{r}_i - r_i|}{r_i} \times 100 \quad ,$$

where $\bar{r}_i$ = mean estimate of the failure rate for the i th phase[2]

and r_i = specified failure rate for the i the phase.

This measure of error was calculated at the end of each phase and used to trace the accuracy of the model over

---

[2] Sample may be less than the 100 replications simulated. See footnote 1, page 17.

all phases of each test case. This estimate error, as a percentage of the actual failure rate, can be found in the tabulated statistics for each Data Set of the tests contained in the appendices.

2. Variability

A manager, considering a reliability growth model for use in a program, will not only be concerned with the model's accuracy, but will be concerned with the variability of the estimates the model provides.

The simulation used for this evaluation was replicated 100 times. The mean estimates used to evaluate the tracking and measure the accuracy of the model only have value over the long run. A manager, however, is primarily interested in the one real application of the model. He is concerned with how well a model performs for a single replication and is thus ultimately concerned about the variability of the estimates he gets from the model in addition to its tracking accuracy.

The measure of variability used for this study was the standard deviation about the mean estimate of the failure rate, $\bar{\hat{r}}_i$,

$$S.D.(\hat{r}_i) = \sqrt{\frac{1}{K} \Sigma (\hat{r}_i - \bar{\hat{r}}_i)^2} \quad ,$$

where K = number of replications that yielded estimates.

As with the failure rate percent error, the standard deviation of the failure rate estimate is contained in the tabulated statistics for each data set.

V. RESULTS

A. GENERAL DESCRIPTION

The results of the analysis are presented in the following manner. The output for each test is contained in a separate appendix to this paper. A data set is identified at the top of each page. This heading consists of the case number and the number of items for the data set. The output for each data set consists of two parts; the tabulated statistics and a performance plot. Figure 6 is a sample of the presentation of the results of a typical data set.

1. Tabulated Statistics

The input parameters, model estimates, measures of performance, and system status at the end of each phase of testing are tabulated for each data set. The values given are the average values over all replications for the data set. Figure 6 shows the format of the tabulated results. The following paragraphs describe each line of the format.

a. Input Parameters

(1) PHASE. This line indicates the phase of testing for the results listed below. Throughout the appendices, results for 6- and 16-phase growth patterns are presented. For 16-phase cases, the first 8 phases are tabulated above a row of asterisks. The same format is then repeated below the asterisks for phases 9 through 16.

CASE 1

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7020	0.4340	0.3200	0.2550	0.2130	0.1833	0.1610	0.1440
PLANNED TEST TIME	0.2315	0.3745	0.5079	0.6373	0.7630	0.8861	1.0064	1.1266
MODEL ESTIMATE	9.4858	0.6376	0.4502	0.3208	0.2581	0.2308	0.1957	0.1691
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	682.03	46.91	40.70	28.16	21.16	26.14	21.53	16.74
SAMPLE STD DEVIATION	23.0502	0.4566	0.3009	0.1996	0.1228	0.1143	0.0903	0.0685
CUMULATIVE TEST TIME	2.148	5.623	13.306	14.239	23.271	31.330	46.419	56.178
CUMULATIVE FAILURES	1.3300	2.8500	4.5300	5.9300	7.4700	9.1500	10.6200	12.7100

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.1330	0.1160	0.1090	0.1010	0.0936	0.0876	0.0823	0.0776
PLANNED TEST TIME	1.2219	1.3775	1.4913	1.6091	1.7363	1.8552	1.9747	2.0943
MODEL ESTIMATE	0.1523	0.1385	0.1246	0.1127	0.1055	0.0977	0.0912	0.0858
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	14.48	17.24	14.29	11.61	12.76	11.58	10.85	10.54
SAMPLE STD DEVIATION	0.0534	0.0447	0.0367	0.0332	0.0298	0.0265	0.0219	0.0203
CUMULATIVE TEST TIME	62.421	75.054	88.887	103.021	116.802	136.857	155.152	174.540
CUMULATIVE FAILURES	13.5200	15.0400	16.4500	17.7900	19.3500	20.8200	22.3200	23.8000

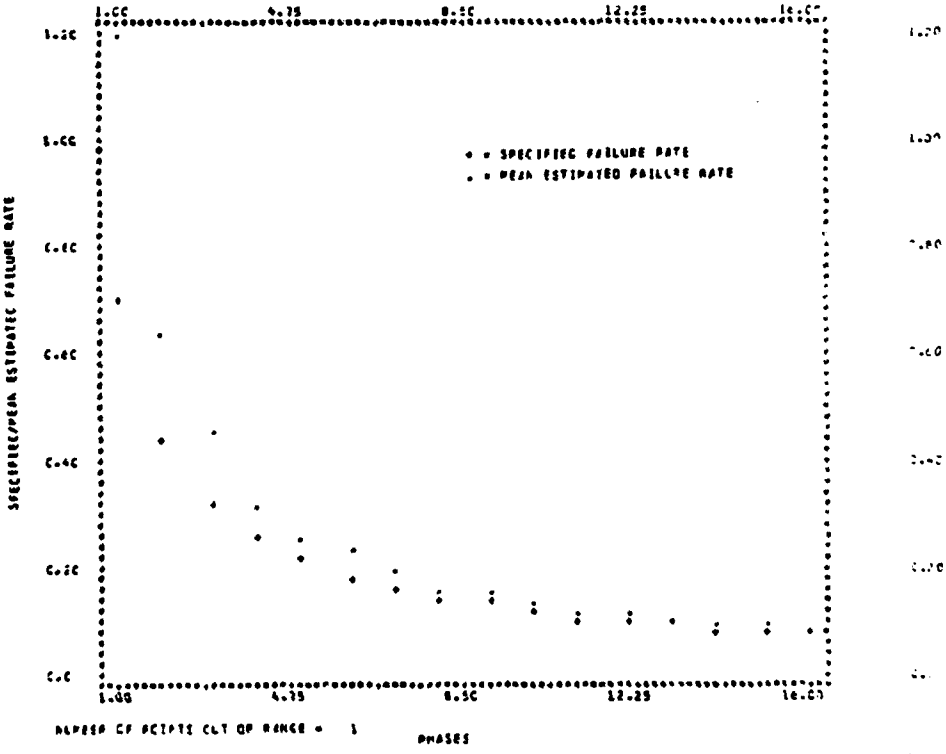


Figure 6. Format for Results of a Data Set

(2) ACTUAL FAILURE RATE. This row consists of the sequence of specified failure rates that defines the reliability growth curve for the test case given in the heading. In Figure 6, the specified failure rates for Phases 8 and 9 are 0.1440 and 0.1330 respectively.

(3) PLANNED TEST TIME. Here, the time to which each item was tested if it did not fail, is given. This number was based on the actual failure rate and the specified probability of survival for the test. This test time was the same for all items tested in a phase. For example, 10 items were tested in each of the 16 phases shown in Figure 6. Those items tested in Phase 8 were tested for 1.1286 time units or until failure.

b. Model Estimates

(1) MODEL ESTIMATE. Line 4 of Figure 6 contains the estimates of the failure rate provided by the AMSAA model (see Section IV-A) for each phase of testing. Referring to Figure 6, it can be seen that the model estimate of the failure rate at the end of the 8th Phase of testing was 0.1681 as compared to the actual failure rate of 0.1440.

c. Measures of Performance

(1) ESTIMATE ERROR. Here, the estimate error as a percentage of the actual failure rate, is given. Again, looking at the results for Phase 8, the percent error of 16.75 is found. This was computed as follows:

$$\frac{0.1681 - 0.1440}{0.1440} \times 100 = 16.74$$

The difference in the two percent errors is due to the extra accuracy carried by the computer.

(2) SAMPLE STD DEVIATION. The next line of entries is the standard deviation of the model estimate. This criteria is discussed in Section IV-B. The standard deviation of the model estimate for Phase 8 is 0.0685.

d. System Status

(1) CUMULATIVE TEST TIME. This row contains the total test time over all items as of the end of the indicated phase. At the end of the 8th Phase of testing, 51.176 time units of testing had been performed on the system.

(2) CUMULATIVE FAILURES. The final entry in the table is that of total failures on the system to the end of the phase. As illustrated by Figure 6, an average of 12.01 failures occurred over all replications. This means that, of the 80 items tested to the end of the 8th Phase, 12 failed.

2. Performance Plot

As an aid to evaluating the tracking accuracy of the model, the specified failure rate and the estimated failure rate are plotted for each phase of a test. Figure 6 contains an example of a typical plot.

All failure rates are plotted on a scale of 0 to 1.2. If an estimate is greater than 1.2, it is plotted at 1.2 and is noted as a point "out of range". More precise values of the points plotted can be obtained from the tabulated output above the plot.

The phases, for each failure rate plotted, are scaled on the horizontal axis. By referring to the CUMULATIVE TEST TIME row of the tabulated statistics above the plot, the amount of test time on the system, to the end of a phase, can be found.

For example, in Figure 6, the items tested had 51.176 time units of testing at the end of Phase 8 and 62.421 time units at the end of Phase 9. Thus test Phase 9 consisted of 11.245 time units of testing.

B. TEST 1

The results for Test 1 are given in Appendix A. Model estimates, made when cumulative test times on the system were less than 10 hours, had a high percentage error and large standard deviations. Testing more items per phase tended to provide better estimates earlier in the testing.

1. Non-increasing Failure Rates

As would be expected, the AMSAA model tracks growth patterns that approximate continuously decreasing curves (Case 1) better than those that have drastic step changes (Case 6). The model had a tendency to provide estimates which lag behind the actual value of the failure rate.

This is reflected in the increase in percentage error during the latter phases of testing. As can be seen in Case 4, several phases of constant failure rate will cause the model to lag behind even moderate changes in the failure rate.

2. Failure Rates that Increase

As can be seen in the performance plots of Cases 11 through 18, the AMSAA model has a tendency to smooth oscillations in the failure rate. This also seems to be due to the tendency of the model to provide estimates of the failure rate that lag the actual failure rate when the growth pattern makes large step changes. This characteristic can cause some large percentage errors and standard deviations in the later phases of testing when the failure rate increases for any reason.

C. TEST 2

Test 2 used planned test times generated for a probability of survival of .99. This resulted in far fewer failures during the testing which severely curtailed the model's ability to track a reliability growth pattern.

Appendix B contains the results for some representative cases. As in Test 1, a minimum number of test hours or failures is required for the model to make an accurate estimate. This requirement is not met when a high reliability system is being tested.

The results in Appendix B show a high percent error and a large standard deviation for the estimates made during the test.

D. MODIFICATIONS

As discussed above, the percentage error and the sample standard deviation of the model estimates were high during the early phases of testing and when failure rates increased. In an attempt to reduce this error, the AMSAA model was used in four modified test situations. All four tests used the point estimate of the failure rate

$$r_p = \frac{\text{number of failures during a phase}}{\text{total test time during a phase}} .$$

It should be noted that the number of failures and the test time used to compute the point estimate are not accumulated over all phases but are only for the current phase of testing.

The point estimate, r_p , was used for any phase where the cumulative test time on the system was less than 10 hours. Once the 10 hour threshold was exceeded, AMSAA model estimates were used. These estimates were made using all data from the beginning of testing if the failure rate was not considered to have increased. The four modified tests differed only in their handling of increasing failure rates.

1. Estimating Slope

In order to determine whether the trend of failure rates was increasing, the slope of the trend was estimated. Two methods were used:

a. 2-Point Estimate of Slope

The slope was estimated using the point estimate, r_p, for the current phase and the last estimate, $\hat{r}_{i-1}$, which may have been from the model or a point estimate.

$$\text{Thus} \quad \text{SLOPE} = r_p - \hat{r}_{i-1} .$$

b. 3-Point Estimate of Slope

This method of estimating slope was used to reduce the change that the estimated slope would be affected by a randomly high point estimate. The slope was estimated using the point estimate, r_p, for the current phase and the last two estimates $\hat{r}_{i-1}$ and $\hat{r}_{i-2}$. The slope estimated consisted of two parts:

$$\hat{r}_{i-1} - \hat{r}_{i-2} \quad \text{and} \quad r_p - \hat{r}_{i-1} .$$

For the estimate of the slope to be considered increasing, both parts had to be determined to be increasing.

2. Determining Increasing Slope

Two methods of determining when an estimate of slope could be considered increasing were used. The estimates of slope described above were tested in one of the

following ways for each of the modified tests.

$$\text{SLOPE} \geq .07$$

$$\text{SLOPE} \geq .2\hat{r}_{i-1}$$

3. Modified Tests

Figure 7 shows the composition of each of the four modified tests.

	SLOPE $\geq .07$	SLOPE $\geq .2r_{i-1}$
2-Point Slope Estimate	MOD1 $r_p - r_{i-1} \geq .07$	MOD2 $r_p - r_{i-1} \geq .2r_{i-1}$
3-Point Slope Estimate	MOD3 $r_{i-1} - r_{i-2} \geq .07$ and $r_p - r_{i-1} \geq .07$	MOD4 $r_{i-1} - r_{i-2} \geq .2r_{i-2}$ and $r_p - r_{i-1} \geq .2r_{i-1}$

Figure 7. Composition of the Modified Tests

The results of the modified tests are presented in the appendices as follows:

TEST	APPENDIX
MOD1	C
MOD2	D
MOD3	E
MOD4	F

Cases 4, 13, 15, and 18 are presented for each test.

APPENDIX A

Results of Test 1

The results of Test 1 for Cases 1 through 18 are contained in this appendix. Each case consists of three data sets, one each for 5, 10, and 20 items. The results are presented in two parts; the tabulated statistics and a performance plot. The elements of the tabulated statistics are described below. For 16-phase cases, the first eight phases are presented above the asterisks and the last eight are shown below.

1. Input Parameters

   a. PHASE

   This line indicates the phase of testing for which the elements listed below apply. All statistics are as of the end of the indicated phase.

   b. ACTUAL FAILURE RATE

   This line contains the failure rate specified for the indicated phase. This failure rate was used to generate the exponential failure times used as data for the model.

   c. PLANNED TEST TIME

   This is the test time to which each item was tested if failure did not occur earlier. For Test 1, the planned test times were generated so that the probability of survival was .85.

2. Model Estimates

a. MODEL ESTIMATE

This is the estimate of the failure rate provided by the model for the test phase indicated (See Section IV-A).

3. Measures of Performance

a. ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE

These entries were computed as a measure of accuracy to be used for evaluating the tracking accuracy of the AMSAA model (See Section VI-B).

b. SAMPLE STD DEVIATION

These values were computed as a measure of variability for the estimate error (See Section IV-B).

4. System Status

a. CUMULATIVE TEST TIME

The times listed are the total test time accumulated over all phases of testing to the end of the indicated phase.

b. CUMULATIVE FAILURES

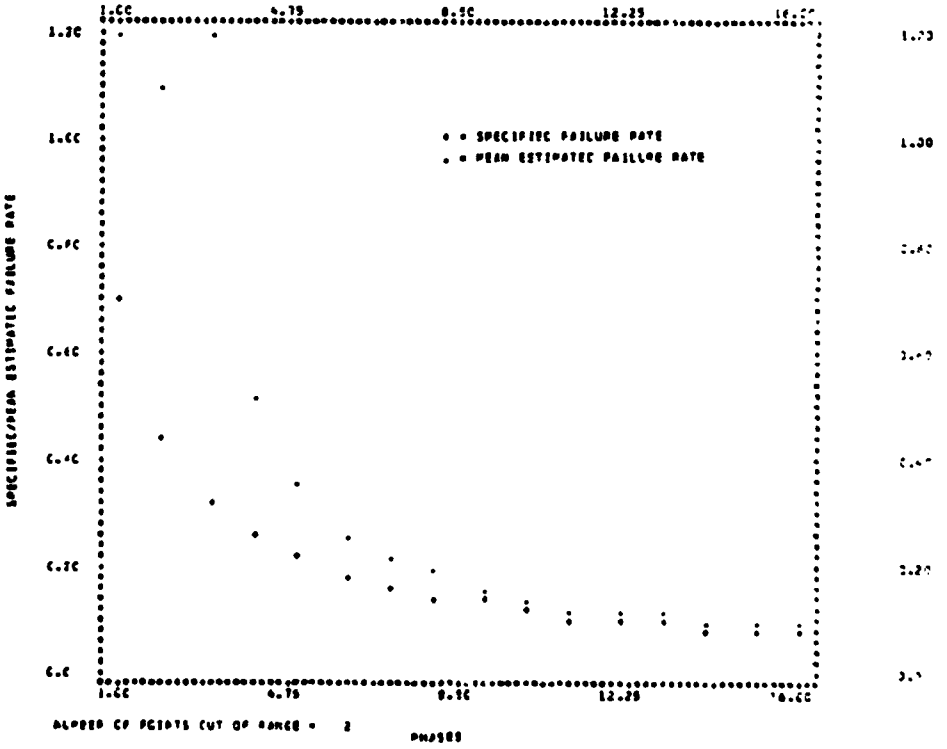
These entries are the total failuares over all items tested for all phases through the indicated phase.

CASE 1

S [illegible]

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7020	0.4340	0.3200	0.2590	0.2130	0.1830	0.1610	0.1440
PLANNED TEST TIME	0.2315	0.3745	0.5079	0.6373	0.7630	0.8681	1.0096	1.1284
MODEL ESTIMATE	2.3197	1.1099	1.7535	0.5154	0.3619	0.2551	0.2240	0.1939
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	230.44	155.73	447.68	102.12	69.72	39.42	36.14	34.35
SAMPLE STD DEVIATION	2.1070	1.2748	7.1630	0.5357	0.2906	0.1362	0.1192	0.1079
CUMULATIVE TEST TIME	1.081	2.822	5.140	8.033	11.513	15.614	20.248	25.447
CUMULATIVE FAILURES	0.5900	1.3100	2.0500	2.9200	3.7700	4.6000	5.2400	5.8000

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.1330	0.1180	0.1090	0.1010	0.0936	0.0876	0.0823	0.0776
PLANNED TEST TIME	1.2219	1.3773	1.4910	1.6091	1.7363	1.8552	1.9747	2.0543
MODEL ESTIMATE	0.1963	0.1390	0.1294	0.1178	0.1112	0.1052	0.0993	0.0908
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	19.78	17.79	18.74	16.59	16.83	20.09	20.69	17.04
SAMPLE STD DEVIATION	0.0778	0.0728	0.0632	0.0557	0.0521	0.0464	0.0457	0.0364
CUMULATIVE TEST TIME	31.248	37.694	44.478	51.958	59.839	68.251	77.254	86.956
CUMULATIVE FAILURES	6.5600	7.1400	8.0000	8.7000	9.5100	10.3200	11.1200	11.9000

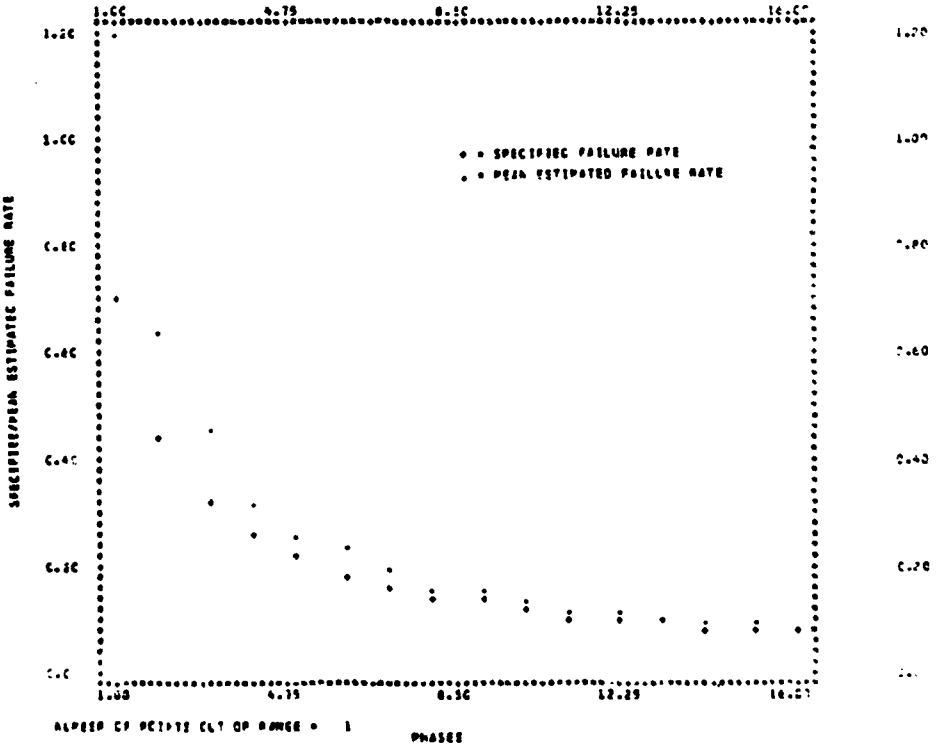


CASE 1

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7020	0.4340	0.3200	0.2550	0.2130	0.1830	0.1610	0.1440
PLANNED TEST TIME	0.2315	0.3745	0.5079	0.6373	0.7630	0.8881	1.0094	1.1286
MODEL ESTIMATE	5.4898	0.6276	0.4502	0.3208	0.2581	0.2308	0.1957	0.1691
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	682.03	44.61	40.70	28.16	21.16	26.14	21.53	16.75
SAMPLE STD DEVIATION	23.0952	0.4566	0.3009	0.1996	0.1228	0.1143	0.0903	0.0685
CUMULATIVE TEST TIME	2.148	5.623	10.309	16.239	23.271	31.330	40.675	51.176
CUMULATIVE FAILURES	1.3300	2.8500	4.5300	6.6300	7.4700	9.1900	10.8200	12.0100

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.1330	0.1180	0.1090	0.1010	0.0936	0.0876	0.0823	0.0776
PLANNED TEST TIME	1.2219	1.3373	1.4513	1.6091	1.7363	1.8552	1.9747	2.0943
MODEL ESTIMATE	0.1523	0.1385	0.1246	0.1127	0.1055	0.0977	0.0912	0.0858
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	14.48	17.34	14.29	11.61	12.76	11.58	10.89	10.54
SAMPLE STD DEVIATION	0.0534	0.0447	0.0387	0.0332	0.0298	0.0265	0.0239	0.0207
CUMULATIVE TEST TIME	62.421	75.054	88.887	103.821	119.802	136.867	155.152	174.546
CUMULATIVE FAILURES	13.9200	15.0400	16.4500	17.7900	19.3500	20.8200	22.3200	23.8000

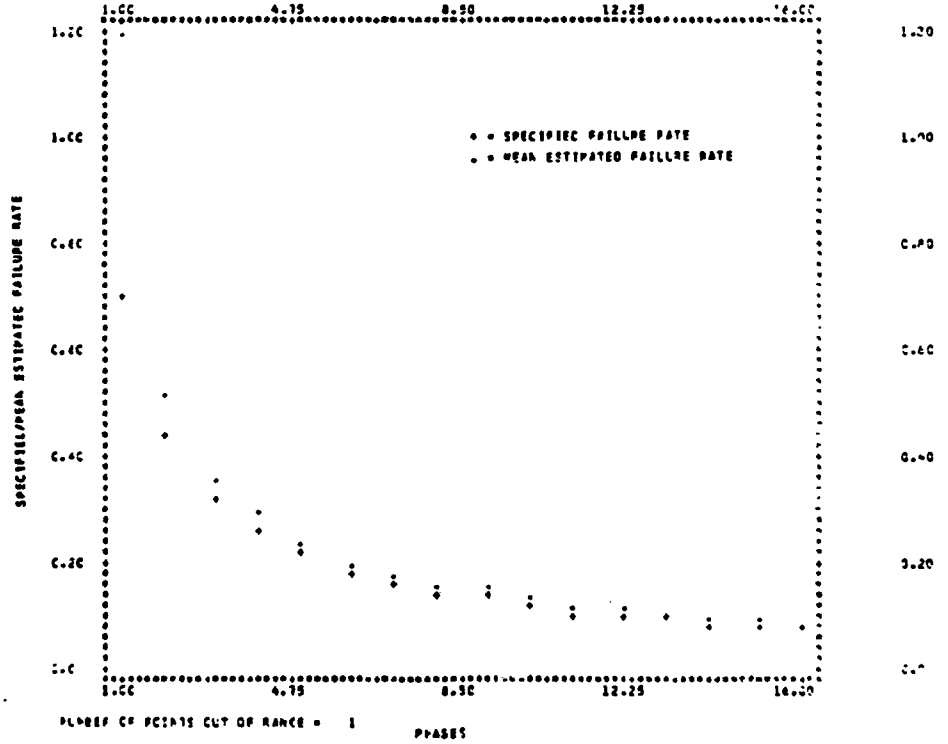


CASE 1

20 TRIALS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7020	0.4340	0.3200	0.2550	0.2130	0.1830	0.1610	0.1440
PLANNED TEST TIME	0.2215	0.3745	0.5079	0.6373	0.7630	0.8881	1.0054	1.1766
MODEL ESTIMATE	1.2651	0.5279	0.3657	0.2902	0.2428	0.2063	0.1835	0.1631
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	80.22	21.64	14.27	13.82	14.47	12.72	14.21	13.24
SAMPLE STD DEVIATION	2.0237	0.3178	0.1490	0.1098	0.0852	0.0654	0.0591	0.0451
CUMULATIVE TEST TIME	4.268	11.149	20.483	32.164	46.215	62.668	81.203	101.470
CUMULATIVE FAILURES	3.0200	6.0600	9.0400	11.9900	15.0800	18.0400	21.2300	24.2000

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.1330	0.1180	0.1060	0.1010	0.0936	0.0876	0.0873	0.0776
PLANNED TEST TIME	1.2219	1.3773	1.4910	1.6091	1.7363	1.8552	1.9747	2.0943
MODEL ESTIMATE	0.1504	0.1383	0.1228	0.1136	0.1058	0.0993	0.0922	0.0892
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	13.08	17.17	12.69	12.45	13.05	13.39	11.67	13.04
SAMPLE STD DEVIATION	0.0362	0.0309	0.0253	0.0229	0.0208	0.0186	0.0165	0.0146
CUMULATIVE TEST TIME	124.427	149.585	177.251	206.690	238.784	272.769	306.935	347.506
CUMULATIVE FAILURES	27.6100	30.8600	33.5300	36.6200	39.7000	42.8700	45.7600	49.2200

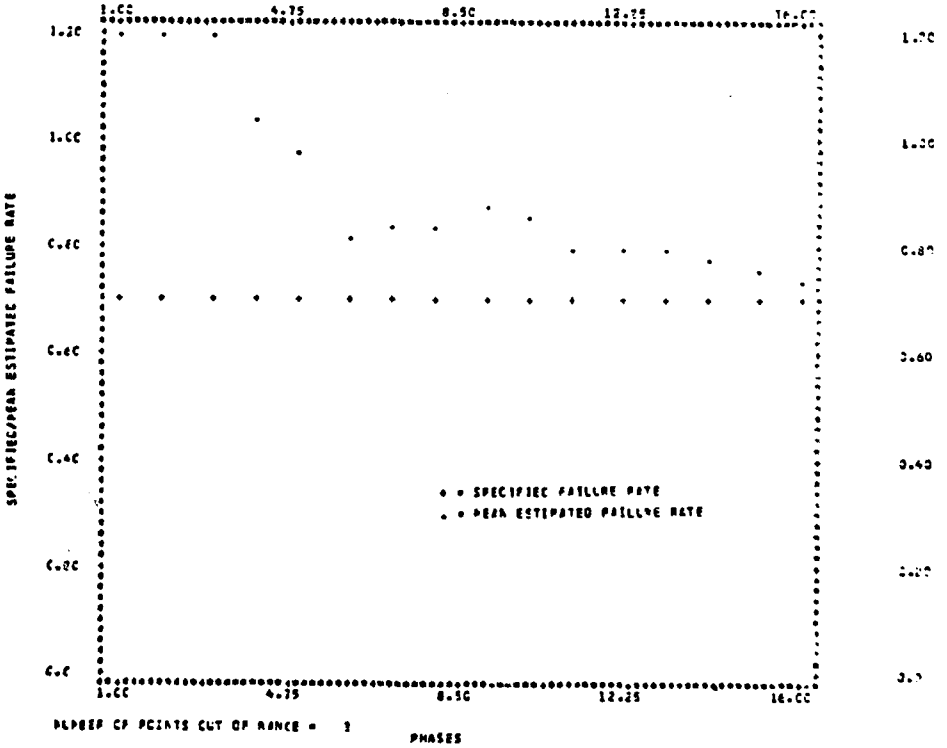


CASE 2

8 STEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	2.5820	3.6035	2.0250	1.0389	0.6716	0.8713	0.8325	0.8341
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	268.86	414.78	189.29	48.41	28.84	17.33	18.93	19.19
SAMPLE STD DEVIATION	2.5461	13.3555	6.3476	0.8193	0.8982	0.5571	0.5512	0.4585
CUMULATIVE TEST TIME	1.063	2.129	3.198	4.280	5.360	6.437	7.497	8.560
CUMULATIVE FAILURES	0.7300	1.5400	2.3400	3.0300	3.7400	4.3800	5.2200	6.0700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	0.8858	0.8688	0.8081	0.7941	0.7958	0.7798	0.7532	0.7324
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	26.54	24.12	15.44	13.44	13.68	11.35	7.60	4.63
SAMPLE STD DEVIATION	0.5660	0.6019	0.4465	0.3672	0.3992	0.3547	0.3149	0.2940
CUMULATIVE TEST TIME	9.630	10.701	11.781	12.854	13.916	14.989	16.072	17.142
CUMULATIVE FAILURES	6.8400	7.5600	8.2100	8.9500	9.7900	10.5500	11.2100	11.8400

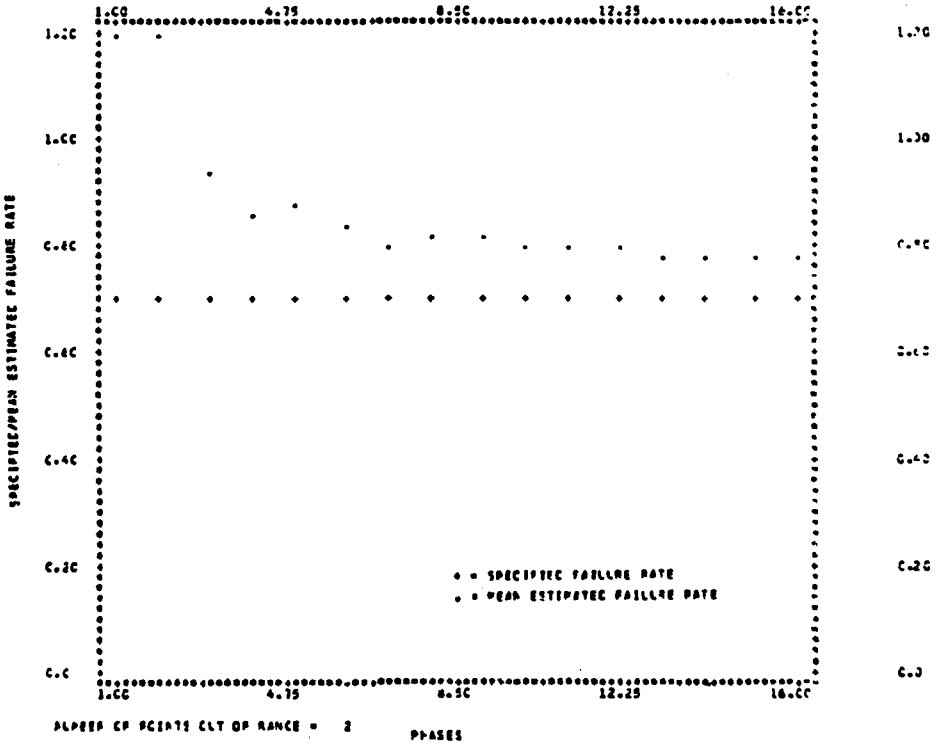


CASE 2

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	2.0018	1.3248	0.9434	0.8589	0.8760	0.8474	0.8319	0.8182
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	185.67	89.26	34.77	22.69	25.14	21.06	18.88	16.88
SAMPLE STD DEVIATION	2.6203	1.1657	0.7177	0.5045	0.4716	0.3647	0.3234	0.3188
CUMULATIVE TEST TIME	2.155	4.289	6.421	8.597	10.720	12.877	15.018	17.148
CUMULATIVE FAILURES	1.3600	3.0600	4.3700	5.6900	7.5800	9.0700	10.5600	12.2600

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	0.8184	0.7970	0.7926	0.7919	0.7857	0.7816	0.7787	0.7747
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	16.91	13.85	13.23	13.12	12.24	11.66	11.24	10.67
SAMPLE STD DEVIATION	0.3175	0.2945	0.2765	0.2596	0.2372	0.2249	0.2167	0.2070
CUMULATIVE TEST TIME	19.274	21.417	23.550	25.680	27.822	29.960	32.095	34.230
CUMULATIVE FAILURES	13.8600	15.3100	16.9100	18.5100	20.0600	21.5900	23.1300	24.6400

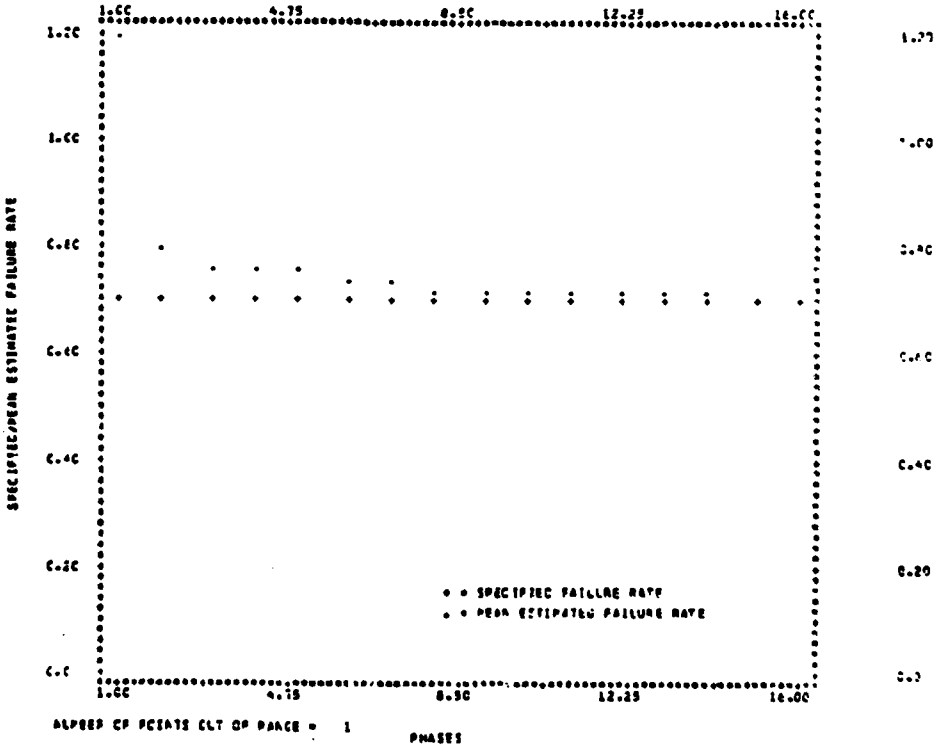


CASE 2

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	1.3931	0.8084	0.7636	0.7644	0.7506	0.7411	0.7355	0.7269
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	93.30	15.49	9.08	9.15	7.23	5.87	5.07	3.78
SAMPLE STD DEVIATION	1.5499	0.4719	0.3593	0.2855	0.2471	0.2083	0.1889	0.1600
CUMULATIVE TEST TIME	4.234	8.548	12.802	17.375	21.356	25.438	29.979	34.223
CUMULATIVE FAILURES	3.3600	6.1400	9.1000	12.3100	15.3800	18.4400	21.5100	24.4700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	0.7158	0.7141	0.7165	0.7197	0.7158	0.7181	0.7196	0.7257
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	2.25	2.01	2.78	2.81	2.26	2.58	1.37	0.81
SAMPLE STD DEVIATION	0.1755	0.1612	0.1664	0.1820	0.1608	0.1567	0.1402	0.1369
CUMULATIVE TEST TIME	38.532	42.403	47.066	51.357	55.636	59.926	64.236	68.542
CUMULATIVE FAILURES	27.3100	30.2800	33.3500	36.4500	39.4700	42.6100	45.6300	48.3600

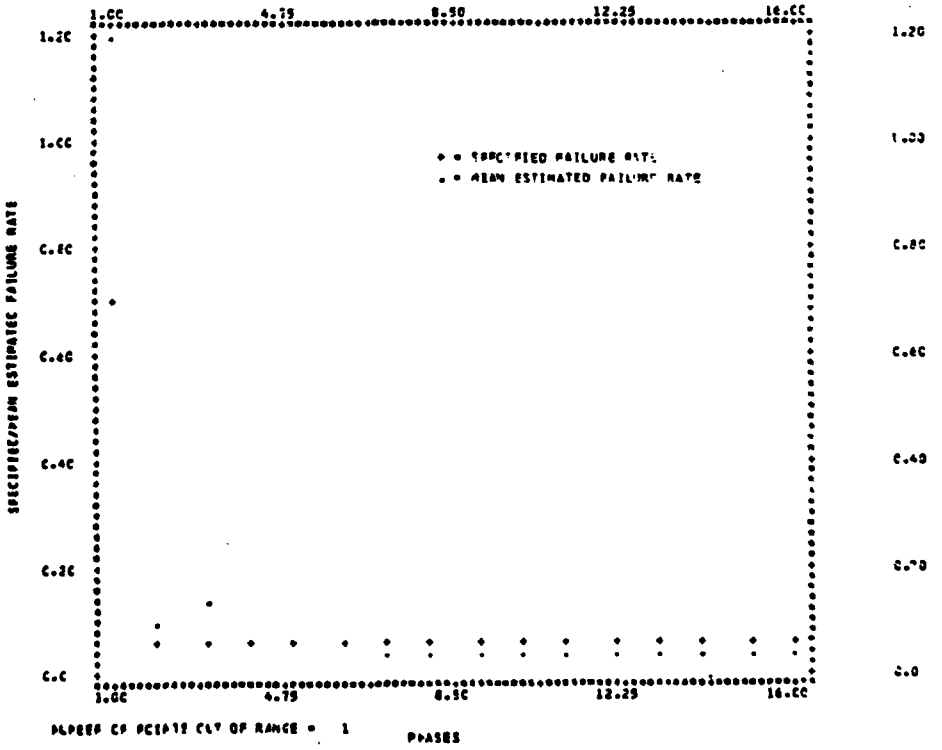


CASE 3

5 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2322	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	2.6444	0.0907	0.1386	0.0548	0.0511	0.0526	0.0480	0.0497
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	277.77	81.30	177.21	9.64	2.17	5.28	4.01	0.59
SAMPLE STD DEVIATION	3.0392	0.0494	0.0117	0.0532	0.0441	0.0452	0.0429	0.0443
CUMULATIVE TEST TIME	1.065	15.695	30.968	46.032	60.571	75.855	91.011	106.100
CUMULATIVE FAILURES	0.6600	1.5200	2.3100	2.9200	3.7000	4.4500	5.1700	5.8300

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.0454	0.0422	0.0425	0.0423	0.0434	0.0453	0.0453	0.0445
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	9.28	15.58	14.94	15.46	13.25	9.38	9.48	11.06
SAMPLE STD DEVIATION	0.0317	0.0262	0.0261	0.0253	0.0232	0.0221	0.0209	0.0196
CUMULATIVE TEST TIME	121.177	136.406	151.504	166.456	181.260	196.131	211.027	226.016
CUMULATIVE FAILURES	6.5600	7.1300	7.8700	8.6500	9.5100	10.4500	11.2100	11.6700

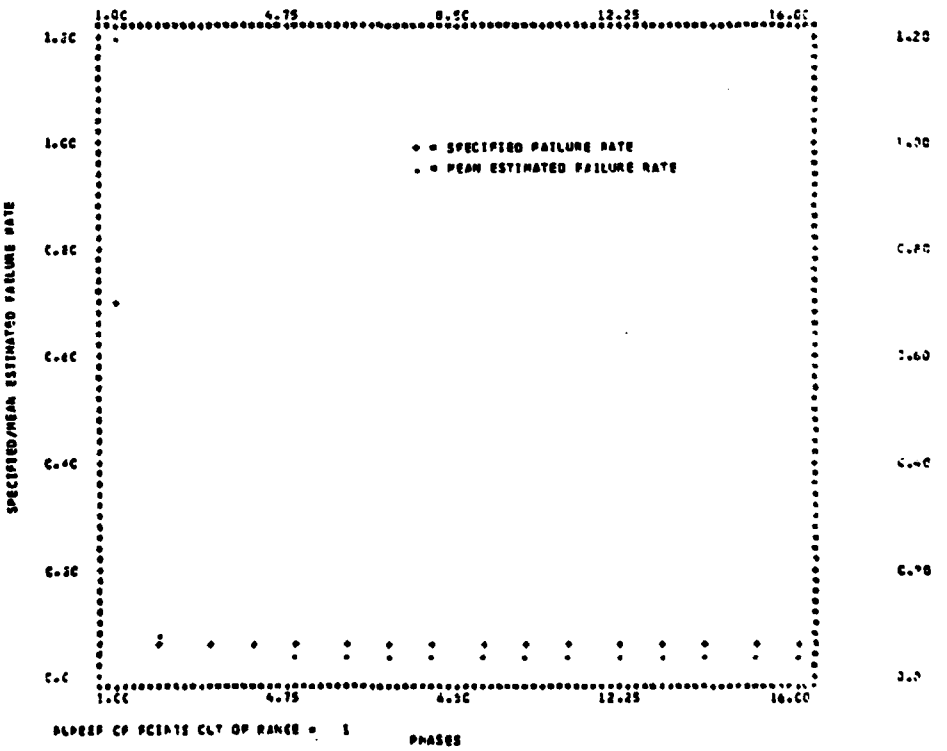


CASE 3

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2322	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	1.6357	0.0818	0.0607	0.0541	0.0482	0.0468	0.0429	0.0444
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	133.68	63.55	21.37	8.20	3.58	6.31	14.12	11.17
SAMPLE STD DEVIATION	1.5047	0.0834	0.0518	0.0457	0.0283	0.0259	0.0197	0.0192
CUMULATIVE TEST TIME	2.157	31.678	61.491	91.432	121.048	150.685	181.030	213.614
CUMULATIVE FAILURES	1.3400	3.1500	4.8300	6.4000	7.9500	9.5200	10.8500	12.4900

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.0441	0.0438	0.0430	0.0432	0.0436	0.0450	0.0456	0.0451
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	11.80	12.42	14.05	13.50	12.86	10.04	8.88	9.71
SAMPLE STD DEVIATION	0.0201	0.0177	0.0177	0.0174	0.0177	0.0194	0.0193	0.0192
CUMULATIVE TEST TIME	240.918	270.784	301.220	331.226	360.931	390.671	420.553	450.738
CUMULATIVE FAILURES	13.9200	15.4400	16.7500	18.2800	19.8300	21.3200	23.1700	24.8900



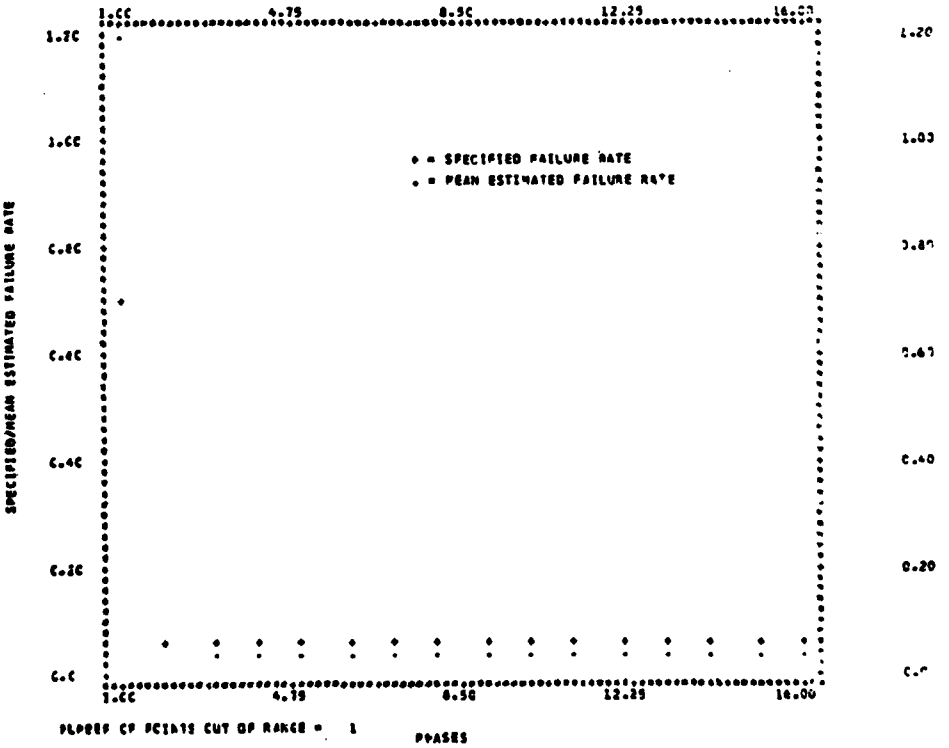
NUMBER OF POINTS OUT OF RANGE = 1

CASE 3

20 ITERS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2322	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	1.2522	0.0345	0.0395	0.0392	0.0401	0.0403	0.0400	0.0402
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	84.61	9.08	21.09	21.58	19.81	20.06	20.00	19.48
SAMPLE STD DEVIATION	1.8262	0.0438	0.0176	0.0142	0.0169	0.0141	0.0129	0.0121
CUMULATIVE TEST TIME	4.323	64.115	124.571	184.251	244.255	304.437	364.456	424.272
CUMULATIVE FAILURES	2.7500	5.8100	8.6700	11.4000	14.2400	17.0100	19.8100	24.6400

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.0406	0.0405	0.0413	0.0419	0.0425	0.0429	0.0423	0.0429
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	18.84	18.90	17.39	17.06	15.04	15.04	15.47	15.06
SAMPLE STD DEVIATION	0.0110	0.0108	0.0105	0.0103	0.0111	0.0110	0.0108	0.0112
CUMULATIVE TEST TIME	484.635	545.173	604.765	665.234	724.717	784.785	844.606	905.236
CUMULATIVE FAILURES	26.9400	29.8000	32.9300	35.8900	38.1000	41.5900	44.7300	47.6600

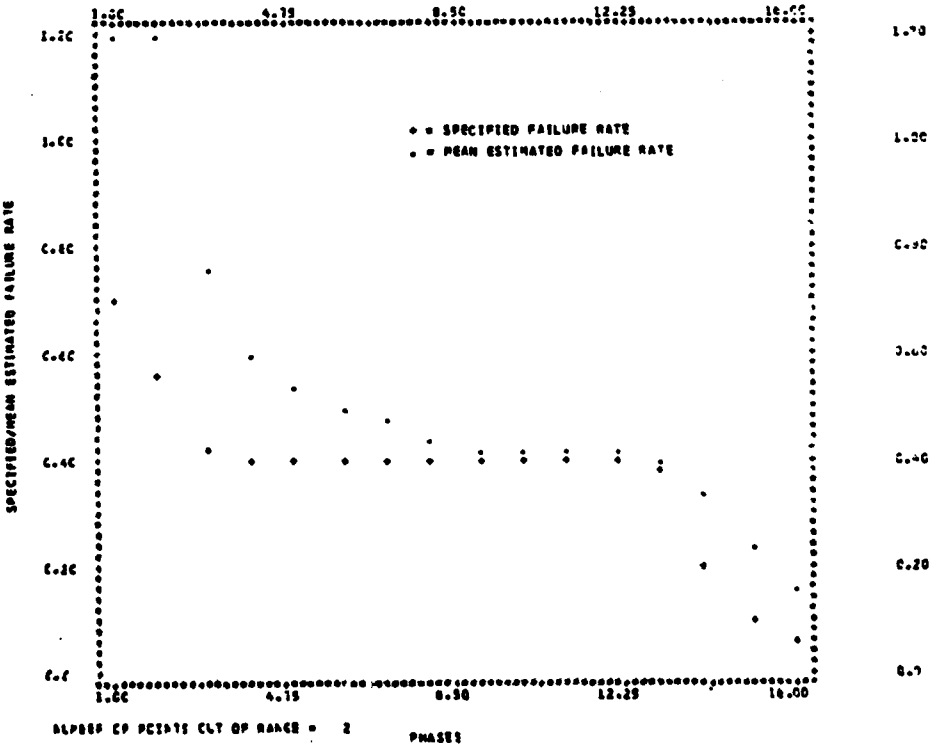


CASE 4

5 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.5500	0.4250	0.4050	0.4000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2955	0.3824	0.4313	0.4563	0.4663	0.4763	0.4863
MODEL ESTIMATE	3.4375	1.8021	0.7642	0.5960	0.5433	0.4942	0.4829	0.4354
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	391.08	227.66	79.81	47.15	35.83	23.56	20.73	8.86
SAMPLE STD DEVIATION	6.9796	2.3862	0.7915	0.4386	0.4800	0.4704	0.3864	0.2626
CUMULATIVE TEST TIME	1.074	2.418	4.202	6.049	7.942	9.841	11.467	13.580
CUMULATIVE FAILURES	0.6400	1.9100	2.1100	2.9100	3.6300	4.2700	5.2700	5.7700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.3750	0.2000	0.1000	0.0500
PLANNED TEST TIME	0.4863	0.4863	0.4863	0.4863	0.4334	0.8126	1.6252	3.2504
MODEL ESTIMATE	0.4266	0.4259	0.4159	0.4204	0.4005	0.3356	0.2469	0.1550
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	6.65	6.46	4.07	5.11	6.79	67.81	146.89	209.99
SAMPLE STD DEVIATION	0.2152	0.1963	0.1891	0.1981	0.2027	0.1483	0.0977	0.0567
CUMULATIVE TEST TIME	15.442	17.316	19.166	21.049	23.079	26.880	34.996	46.304
CUMULATIVE FAILURES	6.5800	7.3400	8.0700	8.7800	9.3800	10.0600	10.8900	11.4400

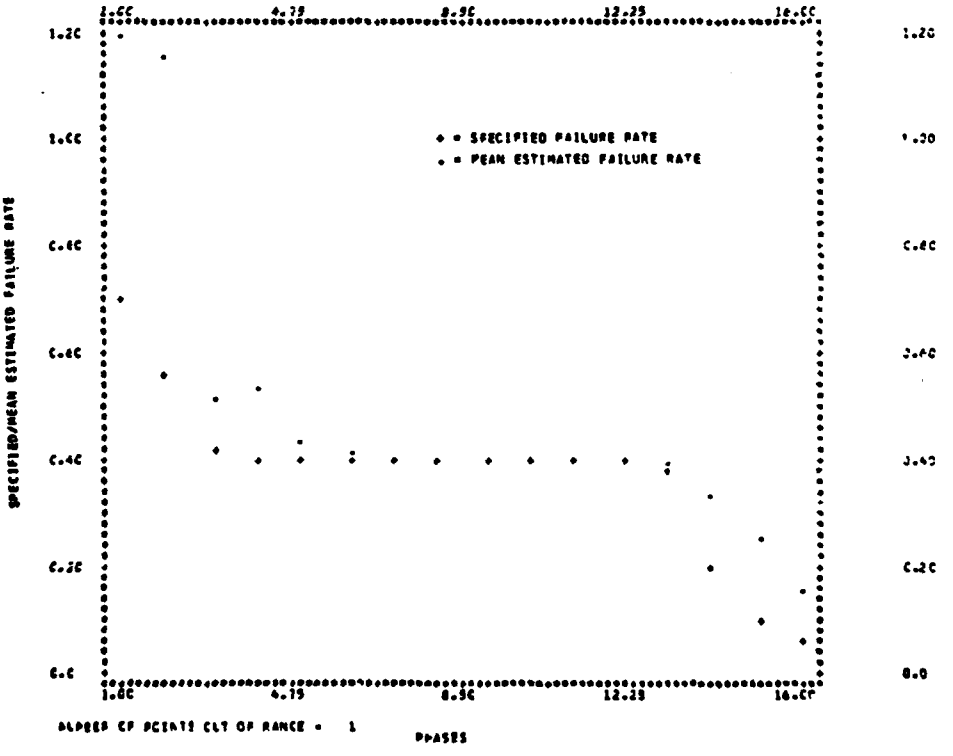


CASE 4

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.5500	0.4250	0.4050	0.4000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2959	0.3824	0.4013	0.4063	0.4063	0.4063	0.4063
MODEL ESTIMATE	2.9592	1.1648	0.5144	0.5460	0.4436	0.4138	0.3964	0.3957
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	322.73	111.77	21.03	34.81	10.90	3.45	0.10	[illegible]
SAMPLE STD DEVIATION	7.4530	3.3214	0.3513	0.5257	0.2234	0.2165	0.1741	0.1626
CUMULATIVE TEST TIME	2.136	4.887	8.462	12.133	15.882	19.633	23.410	27.196
CUMULATIVE FAILURES	1.5400	2.9400	4.1400	5.8400	7.2100	8.4400	10.1000	11.9200

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.3750	0.2000	0.1000	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	0.4334	0.6126	1.0257	2.0504
MODEL ESTIMATE	0.3545	0.3527	0.3932	0.3548	0.3631	0.3440	0.2548	0.1571
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	1.37	1.84	1.70	1.31	4.84	72.02	154.81	214.20
SAMPLE STD DEVIATION	0.1511	0.1524	0.1344	0.1347	0.1179	0.0856	0.0648	0.0333
CUMULATIVE TEST TIME	30.543	34.723	38.459	42.187	46.178	53.627	68.585	98.331
CUMULATIVE FAILURES	13.0700	14.4500	16.0100	17.5700	19.1600	20.8000	22.3600	23.9200



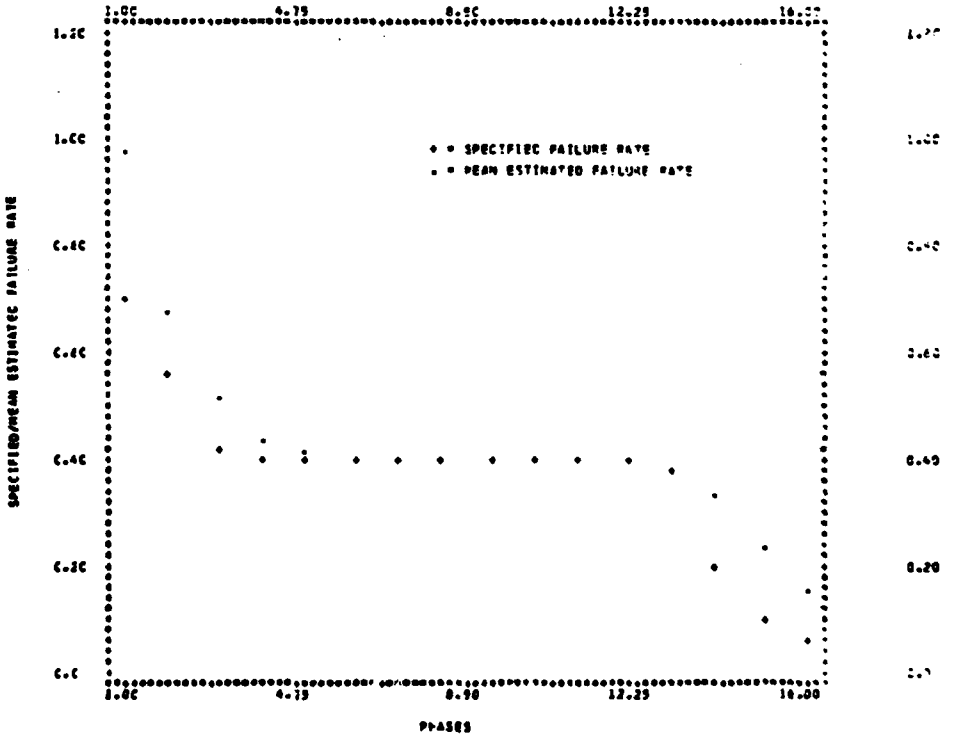
NUMBER OF POINTS OUT OF RANGE = 1

CASE 4

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.5000	0.4250	0.4050	0.4000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2955	0.3824	0.4013	0.4063	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.9732	0.6785	0.5168	0.4366	0.4171	0.4093	0.4017	0.4060
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	39.02	23.37	21.59	7.80	4.28	1.22	0.42	1.50
SAMPLE STD DEVIATION	0.7062	0.4160	0.2553	0.1704	0.1717	0.1370	0.1267	0.1190
CUMULATIVE TEST TIME	4.313	9.798	16.674	24.303	32.768	36.722	44.769	54.188
CUMULATIVE FAILURES	2.9500	5.0000	8.8700	11.7100	14.7100	17.7400	20.8100	24.0300

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.3750	0.2000	0.1000	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	0.4334	0.8126	1.6252	3.2504
MODEL ESTIMATE	0.3959	0.4033	0.3981	0.3941	0.3861	0.3766	0.2442	0.1515
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	0.03	0.83	0.48	1.49	2.97	88.29	144.21	231.76
SAMPLE STD DEVIATION	0.1101	0.1160	0.1023	0.0970	0.0918	0.0766	0.0454	0.0272
CUMULATIVE TEST TIME	61.674	69.123	76.472	84.172	92.154	107.194	137.320	197.432
CUMULATIVE FAILURES	27.0400	30.2200	33.2300	36.1700	39.0400	42.0800	44.8000	47.8000

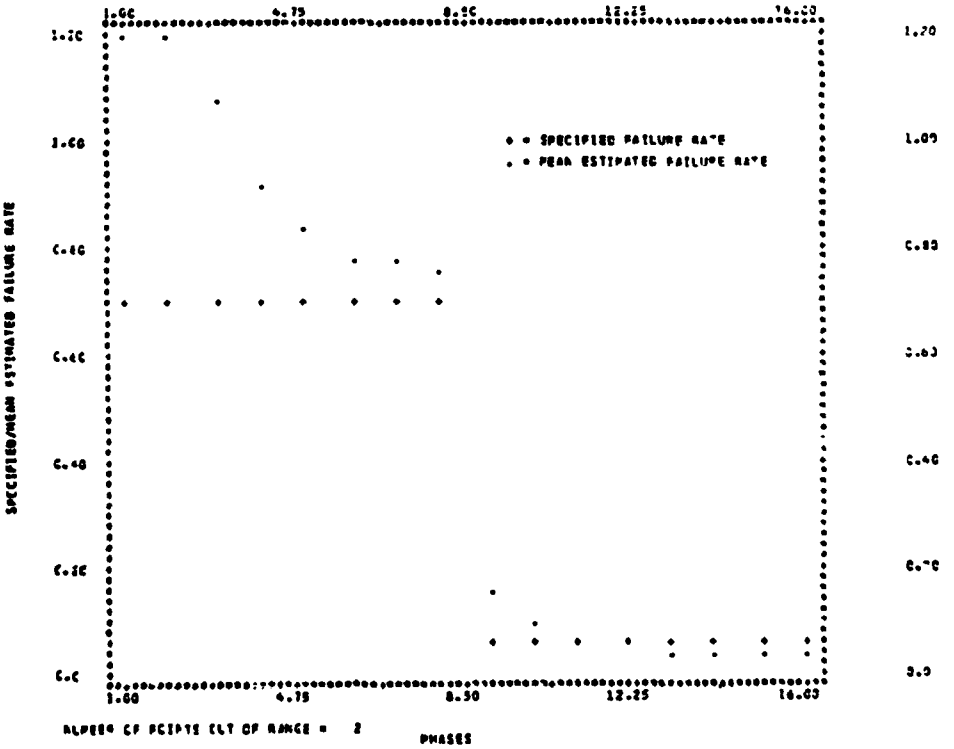


CASE 5

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	1.4873	1.3567	1.0846	0.9184	0.8584	0.7754	0.7719	0.7577
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	112.43	93.82	54.64	31.20	19.77	10.77	10.27	8.24
SAMPLE STD DEVIATION	1.2429	1.0888	0.9333	0.8204	0.4628	0.3504	0.3441	0.3142
CUMULATIVE TEST TIME	2.100	4.312	6.455	8.609	10.764	12.932	15.078	17.222
CUMULATIVE FAILURES	1.3600	3.7800	4.4100	5.8500	7.3400	8.8500	10.1400	11.6600

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.1583	0.0929	0.0657	0.0565	0.0496	0.0462	0.0438	0.0419
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	216.05	85.82	34.45	12.96	0.25	7.64	12.45	16.25
SAMPLE STD DEVIATION	0.0502	0.0320	0.0249	0.0186	0.0152	0.0134	0.0122	0.0114
CUMULATIVE TEST TIME	47.306	77.465	107.616	137.666	167.677	197.535	227.437	257.471
CUMULATIVE FAILURES	13.0800	14.9500	16.0300	17.2900	18.7300	20.2900	21.8600	23.3800

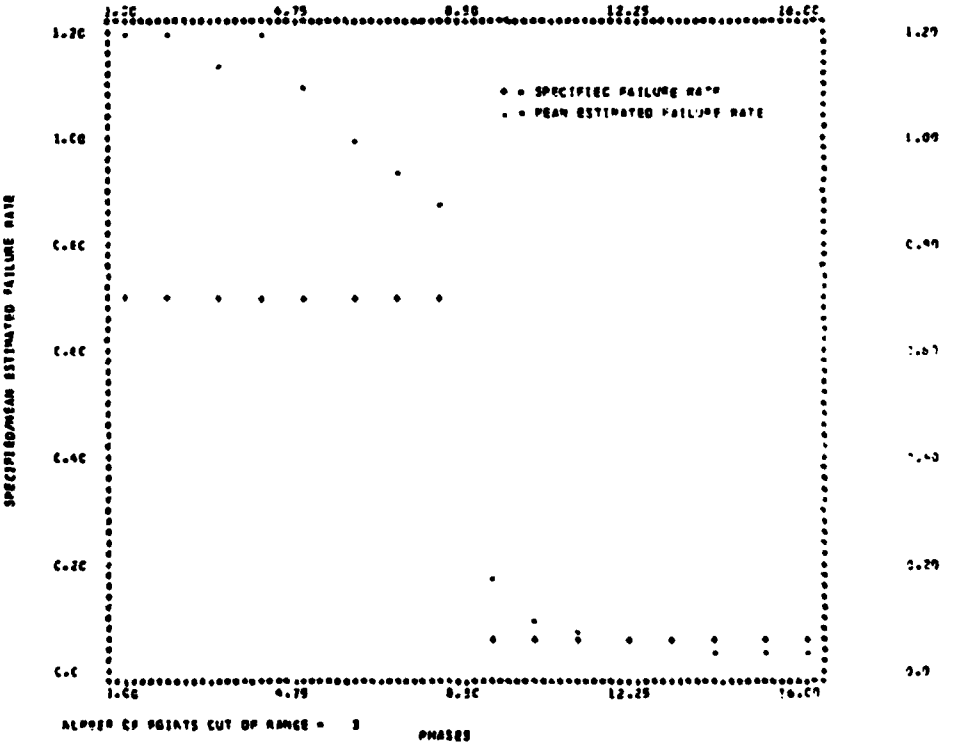


CASE 9

9 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	7.0034	1.7600	1.1644	1.0976	1.0085	1.0012	0.9640	0.8712
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	903.44	151.43	63.49	142.52	55.79	43.03	34.89	24.46
SAMPLE STD DEVIATION	27.8616	1.6287	1.0663	5.6117	0.5275	0.7431	0.5974	0.6847
CUMULATIVE TEST TIME	1.078	2.163	3.241	4.319	5.386	6.461	7.539	8.618
CUMULATIVE FAILURES	0.6000	1.3000	1.9000	2.8000	3.5000	4.2100	5.1700	5.8700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.1735	0.0938	0.0713	0.0610	0.0526	0.0488	0.0492	0.0437
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	247.04	87.68	41.95	22.09	5.11	2.45	1.61	12.67
SAMPLE STD DEVIATION	0.1209	0.0415	0.0288	0.0272	0.0225	0.0211	0.0220	0.0173
CUMULATIVE TEST TIME	23.741	38.931	53.903	68.700	83.615	98.725	113.771	128.797
CUMULATIVE FAILURES	6.5300	7.1900	7.9300	8.7100	9.3700	10.1700	10.8200	11.4700

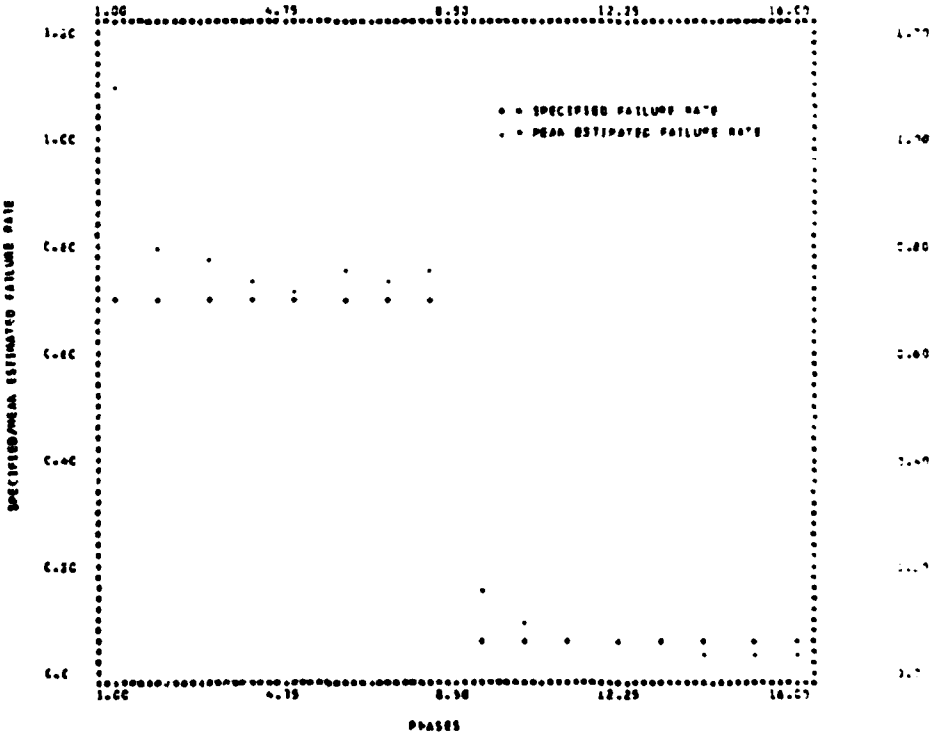


CASE 9

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	1.0561	0.7566	0.7445	0.7491	0.7287	0.7215	0.7097	0.7051
ESTIMATE BIASED AS PERCENTAGE OF ACTUAL FAILURE RATE	50.88	13.81	12.37	6.45	4.10	3.36	3.11	2.87
SAMPLE STD DEVIATION	0.6540	0.4466	0.3826	0.3081	0.2635	0.2303	0.2049	0.1854
CUMULATIVE TEST TIME	4.238	8.596	12.602	17.214	21.527	25.764	30.766	34.132
CUMULATIVE FAILURES	3.0400	5.8000	8.6200	11.6600	14.9700	17.8400	20.9600	24.2300

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.1018	0.0953	0.0899	0.0865	0.0811	0.0772	0.0738	0.0710
ESTIMATE BIASED AS PERCENTAGE OF ACTUAL FAILURE RATE	223.55	90.66	39.83	16.95	5.29	5.70	12.38	18.49
SAMPLE STD DEVIATION	0.0377	0.0208	0.0154	0.0137	0.0120	0.0108	0.0099	0.0091
CUMULATIVE TEST TIME	94.364	154.544	214.644	274.697	335.177	394.557	455.037	515.517
CUMULATIVE FAILURES	27.1800	38.2600	32.9500	36.0100	34.6500	41.6500	44.9700	47.9200

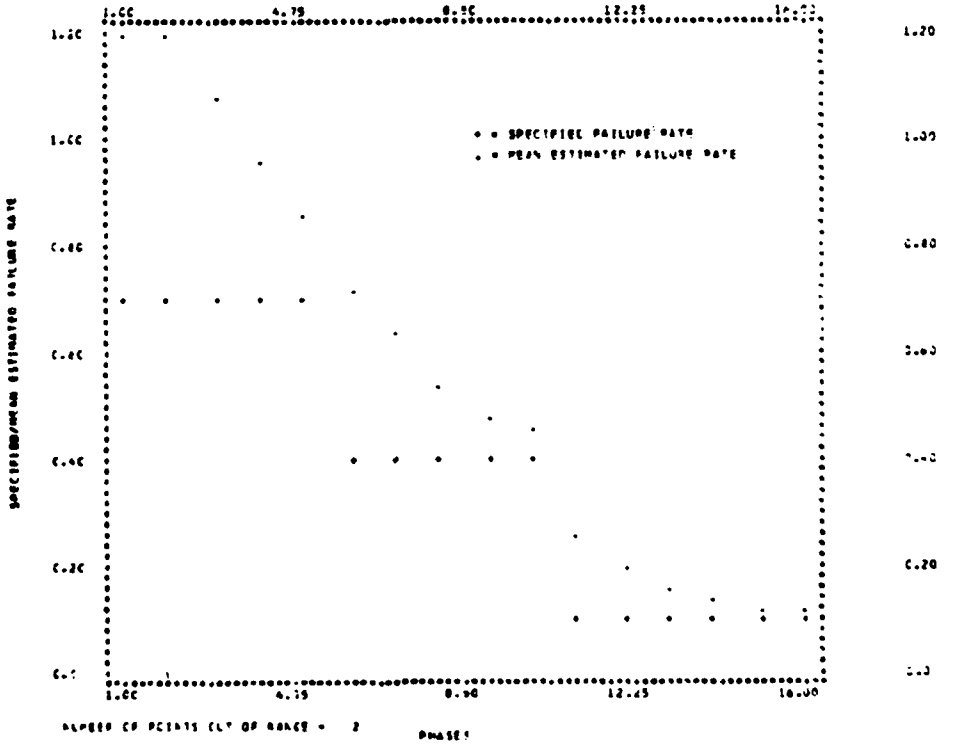


CASE 6

5 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.1372	3.2307	1.3884	0.9594	0.8695	0.7261	0.6367	0.5607
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	1002.49	361.53	98.55	37.35	24.22	81.53	59.54	35.09
SAMPLE STD DEVIATION	41.6542	12.6539	0.8206	0.8237	0.6671	0.5166	0.4158	0.2582
CUMULATIVE TEST TIME	1.361	2.128	3.209	4.305	5.374	7.218	9.075	13.488
CUMULATIVE FAILURES	0.7000	1.4000	2.2200	2.8400	3.5500	4.4600	5.2600	6.0100

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.4063	0.4063	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.4852	0.4554	0.2601	0.1951	0.1638	0.1281	0.1281	0.1195
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	21.30	14.95	160.15	95.07	63.80	28.14	28.06	19.51
SAMPLE STD DEVIATION	0.2158	0.2063	0.1126	0.0776	0.0605	0.0529	0.0478	0.0426
CUMULATIVE TEST TIME	12.456	14.742	22.241	29.722	37.231	44.676	52.044	59.523
CUMULATIVE FAILURES	6.6800	7.3600	8.0900	8.6000	9.7000	10.4000	11.4000	12.1500

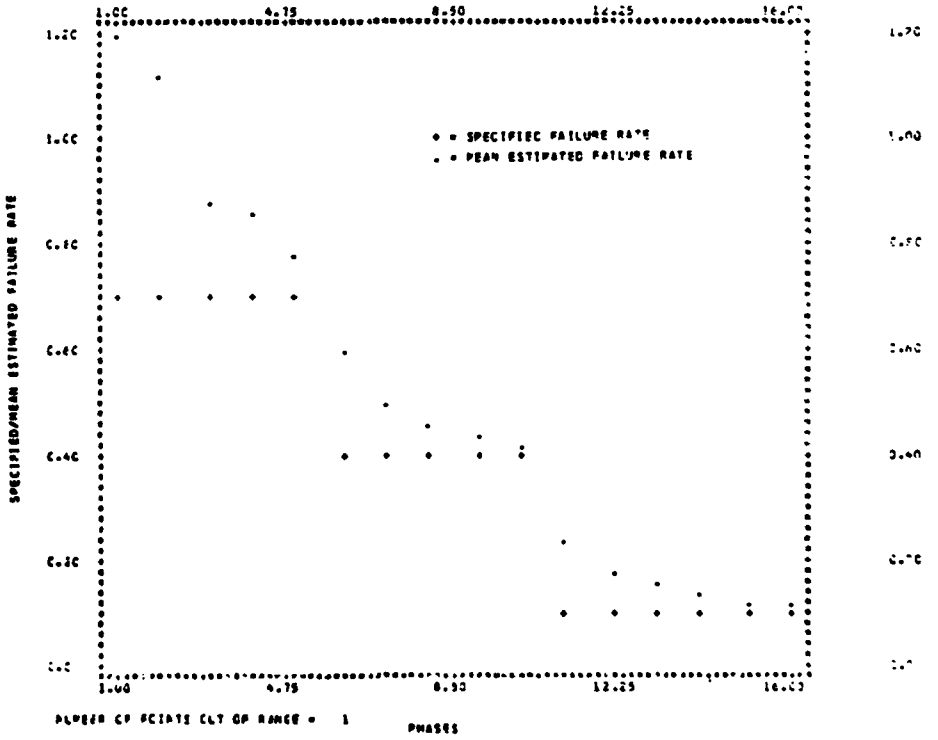


CASE 6

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.4063	0.4063	0.4063
MODEL ESTIMATE	1.7872	1.1281	0.8811	0.8021	0.7812	0.5577	0.5077	0.4506
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	155.31	61.16	25.86	14.59	11.59	39.43	26.92	12.65
SAMPLE STD DEVIATION	1.7462	0.9507	0.5558	0.4681	0.3682	0.2647	0.2068	0.1654
CUMULATIVE TEST TIME	2.158	4.277	6.441	8.553	10.725	14.456	18.287	22.093
CUMULATIVE FAILURES	1.3500	3.0100	4.3300	5.9200	7.2400	8.6600	9.9800	11.2500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.4063	0.4063	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.4356	0.4184	0.2492	0.1983	0.1554	0.1366	0.1236	0.1146
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	8.99	4.61	149.24	98.29	55.45	36.59	23.61	14.60
SAMPLE STD DEVIATION	0.1644	0.1469	0.0863	0.0576	0.0423	0.0383	0.0295	0.0264
CUMULATIVE TEST TIME	25.831	29.565	44.552	59.418	74.439	88.320	104.331	119.306
CUMULATIVE FAILURES	12.7500	14.1900	15.7600	17.4500	19.0200	20.5500	22.1800	23.7400

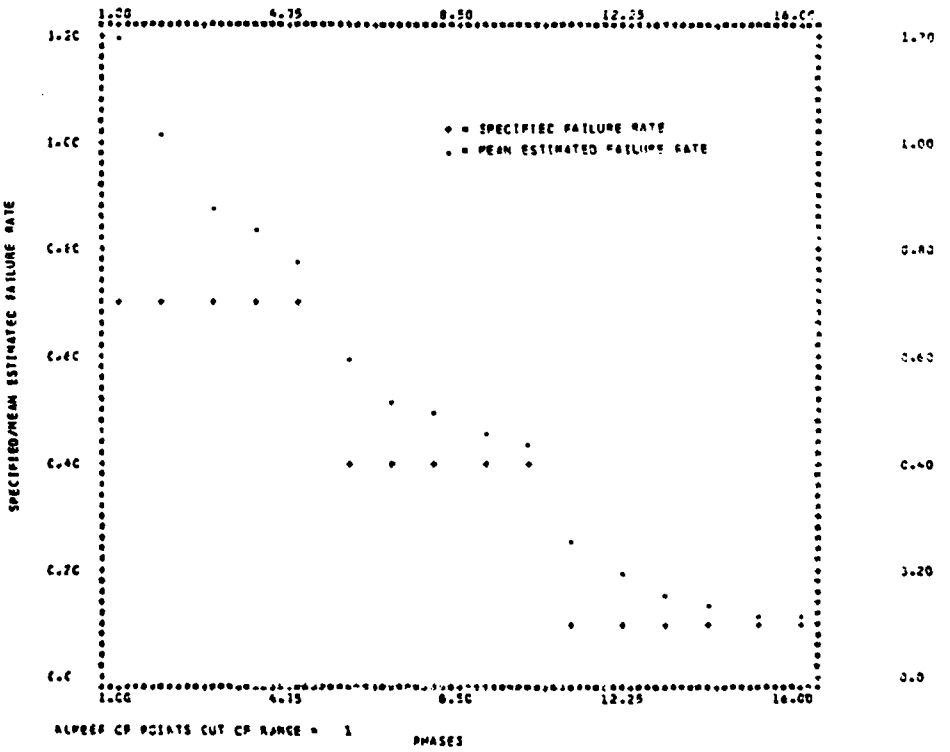


CASE 4

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.4063	0.4063	0.4063
MODEL ESTIMATE	1.2777	1.0114	0.8886	0.8352	0.7894	0.6083	0.5260	0.4656
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	82.53	44.48	26.94	19.32	12.78	52.08	31.49	23.96
SAMPLE STD DEVIATION	1.2163	0.6270	0.4078	0.3046	0.2523	0.1787	0.1497	0.1374
CUMULATIVE TEST TIME	4.294	8.561	12.842	17.130	21.419	28.605	36.410	43.831
CUMULATIVE FAILURES	2.7700	6.0000	9.2000	12.3000	15.2100	18.0700	21.0200	24.2000

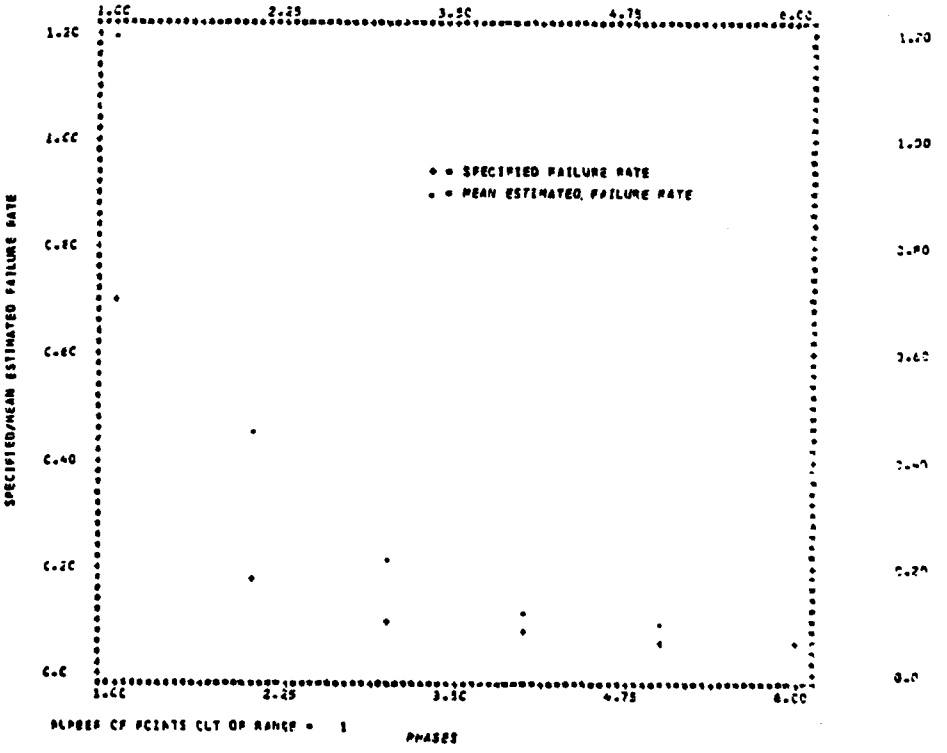
PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.4063	0.4063	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.4351	0.4389	0.2561	0.1931	0.1571	0.1355	0.1213	0.1116
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	13.76	9.72	156.09	93.08	57.10	35.47	21.31	11.65
SAMPLE STD DEVIATION	0.1217	0.1210	0.0658	0.0431	0.0334	0.0276	0.0241	0.0218
CUMULATIVE TEST TIME	51.373	58.856	88.818	118.467	148.459	178.515	208.545	238.697
CUMULATIVE FAILURES	27.0300	30.0400	33.1700	36.4600	39.4300	42.3500	45.2600	48.2700



CASE 7

9 ITEMS

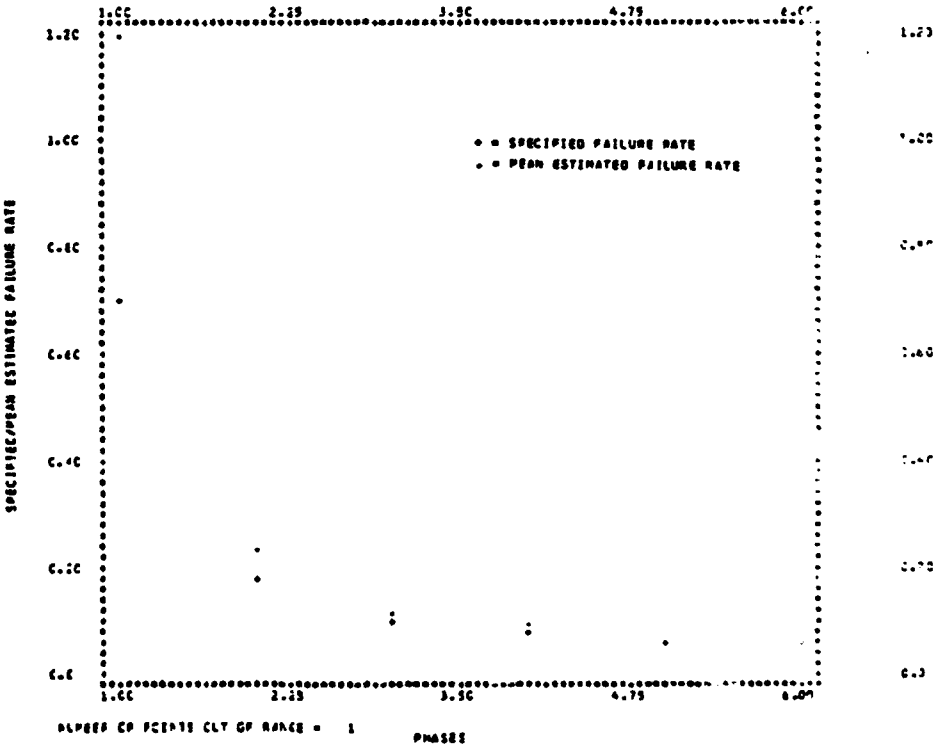
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.1800	0.1060	0.0760	0.0600	0.0500
PLANNED TEST TIME	0.2322	0.9029	1.9332	3.1384	4.7066	9.7904
MODEL ESTIMATE	2.6664	0.4355	0.2102	0.1267	0.0989	0.0648
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	283.92	155.26	98.29	66.74	64.89	29.53
SAMPLE STD DEVIATION	2.2451	0.3773	0.2323	0.2691	0.1488	0.0529
CUMULATIVE TEST TIME	1.082	5.233	12.335	22.415	34.915	46.550
CUMULATIVE FAILURES	0.9800	1.4000	2.1100	2.6800	3.4500	4.2000



CASE 7

10 ITERS

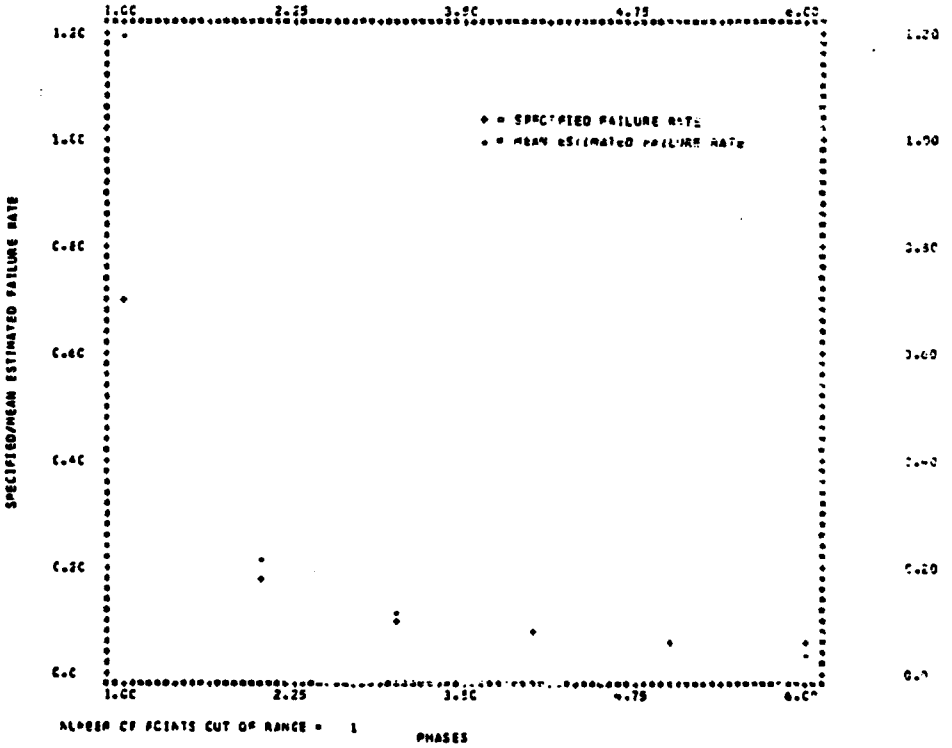
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.1600	0.1000	0.0700	0.0600	0.0500
PLANNED TEST TIME	0.2322	0.9029	1.9322	2.1384	2.7086	3.2704
MODEL ESTIMATE	1.4464	0.2349	0.1188	0.0935	0.0609	0.0525
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	109.49	30.48	12.05	22.99	1.51	4.91
SAMPLE STD DEVIATION	1.9720	0.1645	0.0705	0.1298	0.0258	0.0220
CUMULATIVE TEST TIME	2.131	10.442	24.658	44.542	69.742	99.645
CUMULATIVE FAILURES	1.5200	3.0500	4.5000	5.5700	7.4000	9.3400



CASE 7

20 ITEMS

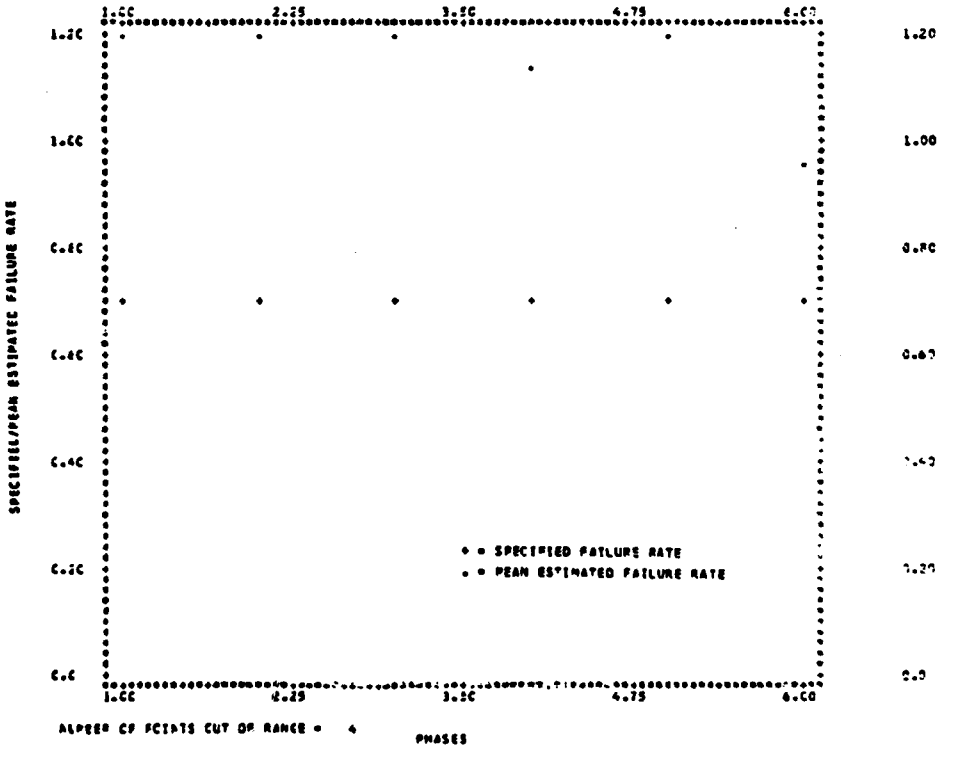
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.1600	0.1000	0.0760	0.0600	0.0503
PLANNED TEST TIME	0.2322	0.9029	1.5332	2.1384	2.7086	3.2504
MODEL ESTIMATE	1.2810	0.2117	0.1117	0.0803	0.0611	0.0496
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	83.00	17.60	5.34	5.63	1.77	0.73
SAMPLE STD DEVIATION	1.1594	0.1266	0.0577	0.0327	0.0204	0.0155
CUMULATIVE TEST TIME	4.285	21.018	49.447	88.959	135.356	186.121
CUMULATIVE FAILURES	3.0500	6.0200	8.8200	11.9600	14.9300	17.8000



CASE 8

9 ITEMS

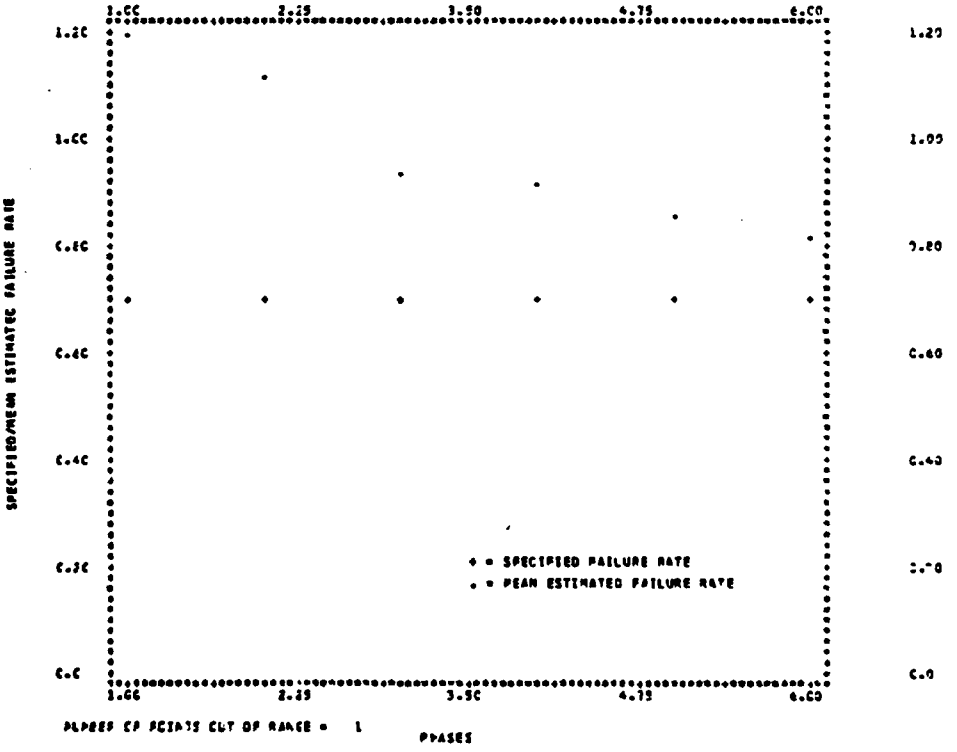
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	6.5483	6.2545	1.5116	1.1498	1.7859	0.9689
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	835.47	793.21	115.95	64.26	155.12	38.42
SAMPLE STD DEVIATION	14.5964	36.6878	1.5868	1.0363	7.2352	0.6883
CUMULATIVE TEST TIME	1.075	2.154	3.221	4.309	5.385	6.462
CUMULATIVE FAILURES	0.6000	1.4400	2.1600	2.8500	3.5700	4.4300



CASE 8

10 ITEMS

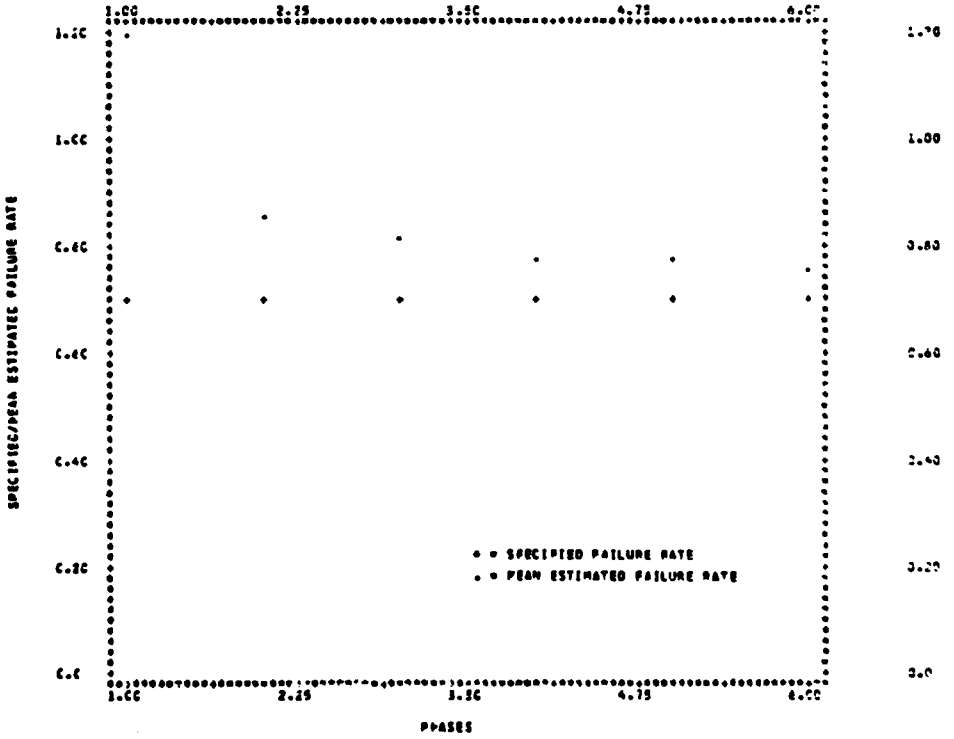
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	1.9109	1.1108	0.9457	0.8227	0.8611	0.8247
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	172.98	58.69	35.07	31.82	23.01	17.82
SAMPLE STD DEVIATION	2.2062	0.9809	0.6116	0.4288	0.4651	0.3530
CUMULATIVE TEST TIME	2.119	4.242	6.362	8.501	10.645	12.788
CUMULATIVE FAILURES	1.6200	3.1100	4.7700	6.4300	7.8100	9.3500



CASE 8

20 ITEMS

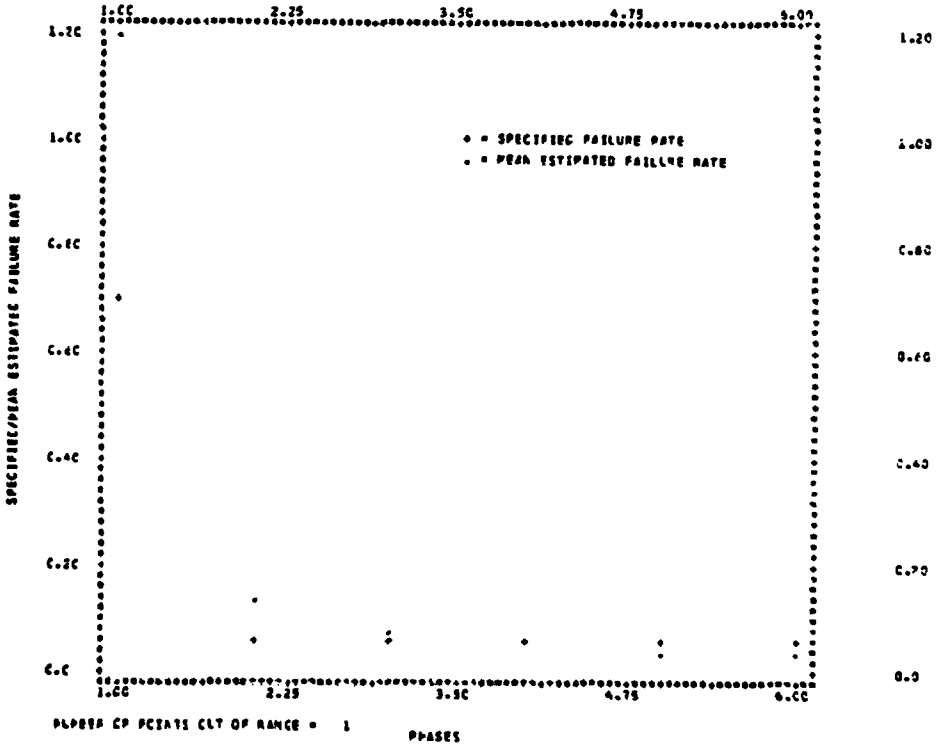
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	1.1674	0.8690	0.8298	0.7837	0.7802	0.7658
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	71.06	24.14	18.54	11.95	11.46	9.40
SAMPLE STD DEVIATION	1.0701	0.4682	0.3564	0.2971	0.2620	0.2382
CUMULATIVE TEST TIME	4.201	8.591	12.843	17.144	21.424	25.696
CUMULATIVE FAILURES	2.9200	6.0000	9.2100	12.1900	15.2700	18.3200



CASE 9

9 ITEMS

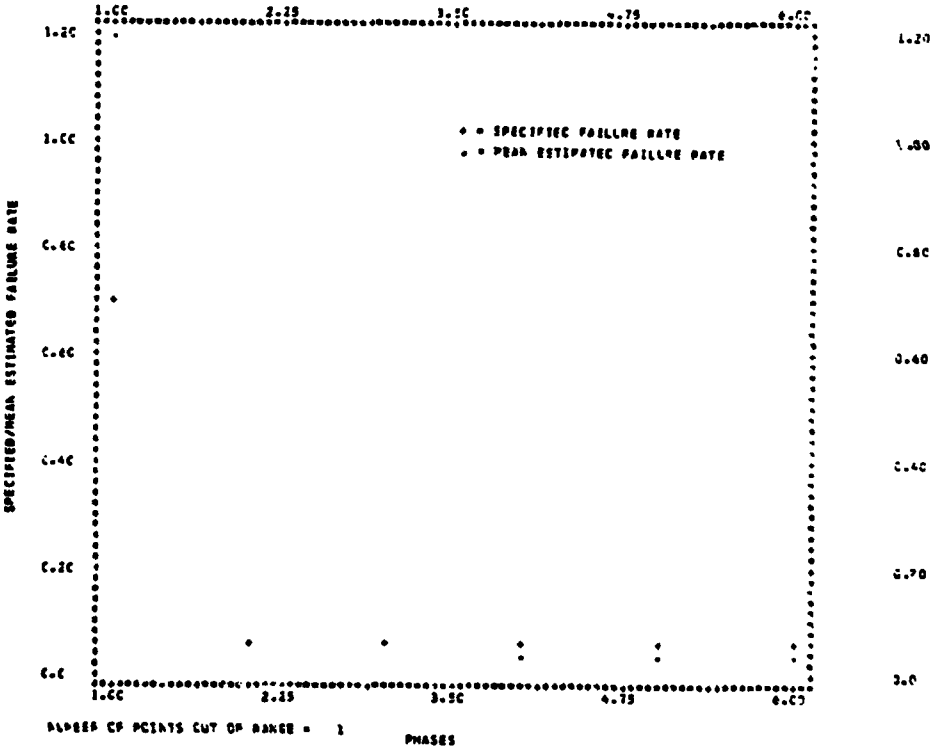
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2322	3.2504	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	3.0001	0.1346	0.0813	0.0563	0.0493	0.0484
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	328.99	169.20	62.64	13.46	2.04	1.25
SAMPLE STD DEVIATION	3.3772	0.4560	0.0523	0.0539	0.0358	0.0257
CUMULATIVE TEST TIME	1.0066	16.0044	30.7116	45.8006	60.8956	75.8856
CUMULATIVE FAILURES	0.7100	1.5100	2.4700	3.1300	3.8400	4.6400



CASE 9

10 STEPS

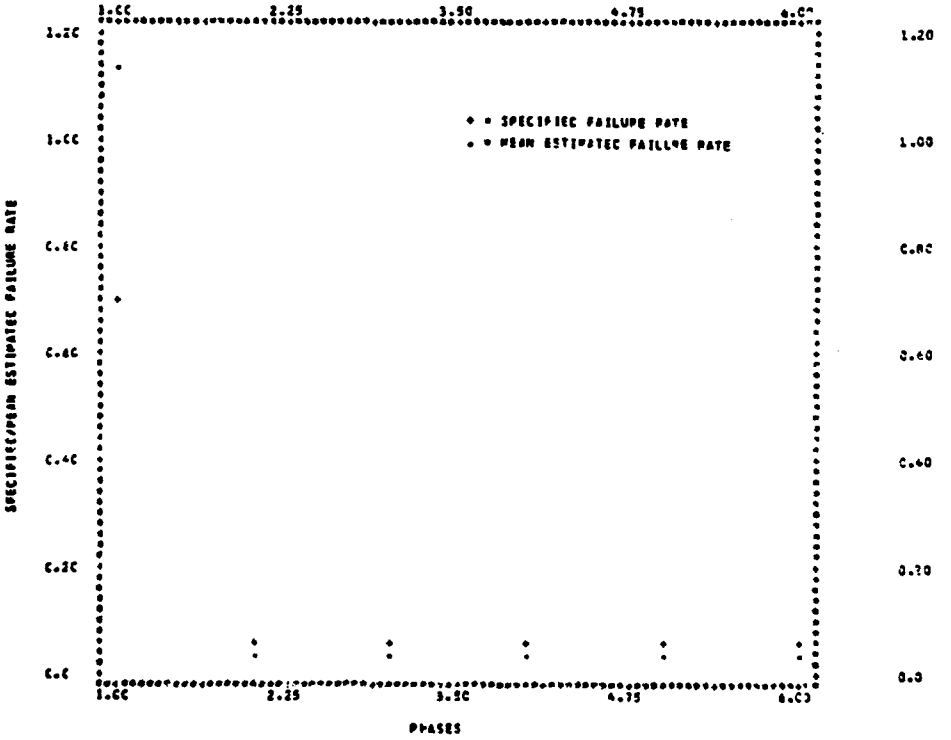
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2322	3.2504	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	1.2220	0.0512	0.0506	0.0392	0.0418	0.0429
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	74.57	2.43	1.22	21.49	16.43	14.07
SAMPLE STD DEVIATION	1.0580	0.0401	0.1258	0.0227	0.0236	0.0249
CUMULATIVE TEST TIME	2.139	32.163	62.384	92.021	121.829	151.788
CUMULATIVE FAILURES	1.4730	2.6500	4.3600	5.9600	7.6500	9.1900



CASE 9

20 ITEMS

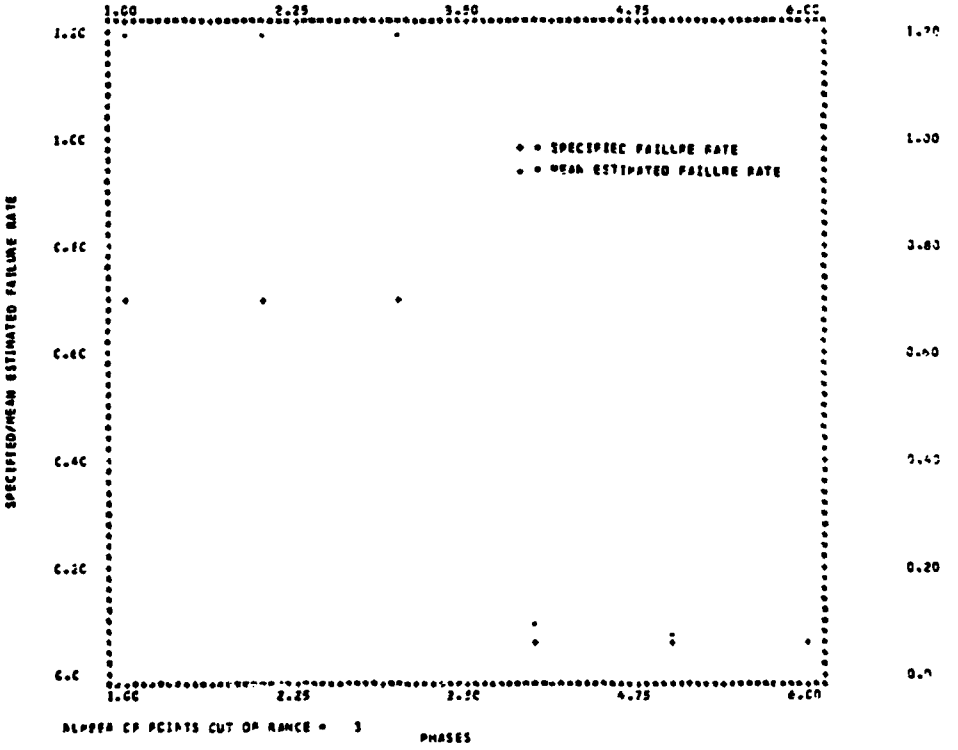
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2322	3.2504	3.2504	3.2504	3.2504	3.2504
POOLED ESTIMATE	1.1359	0.0449	0.0378	0.0392	0.0375	0.0388
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	62.27	10.11	24.46	21.63	24.94	22.44
SAMPLE STD DEVIATION	1.1273	0.0238	0.0163	0.0211	0.0144	0.0132
CUMULATIVE TEST TIME	4.308	64.787	124.386	184.293	244.683	304.586
CUMULATIVE FAILURES	2.8000	5.5400	8.5600	11.6400	14.5200	17.6400



CASE 10

S-STEPS

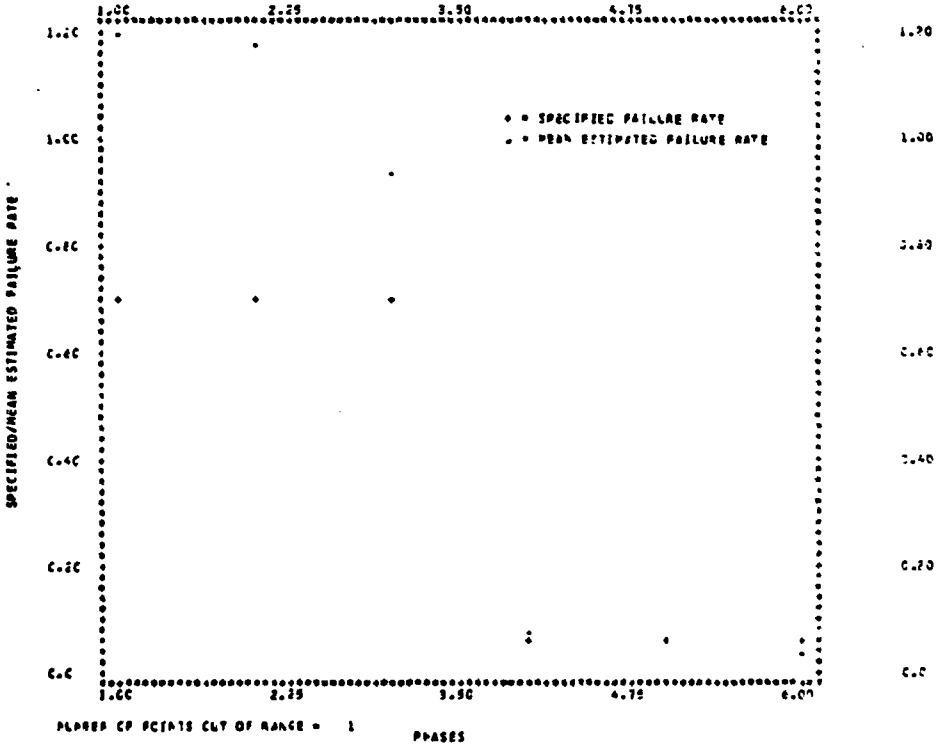
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2322	0.2322	0.2322	3.2504	3.2504	3.2504
MODEL ESTIMATE	3.1201	1.9107	1.4548	0.1021	0.0805	0.0577
ESTIMATE EACH AS PERCENTAGE OF ACTUAL FAILURE RATE	351.44	172.96	107.82	104.23	60.92	15.47
SAMPLE STD DEVIATION	4.1693	1.8739	1.6556	0.0706	0.0783	0.0370
CUMULATIVE TEST TIME	1.078	2.144	3.226	18.175	22.837	47.633
CUMULATIVE FAILURES	0.0000	1.4500	2.0800	2.9500	3.8900	4.6400



CASE 10

10 ITEMS

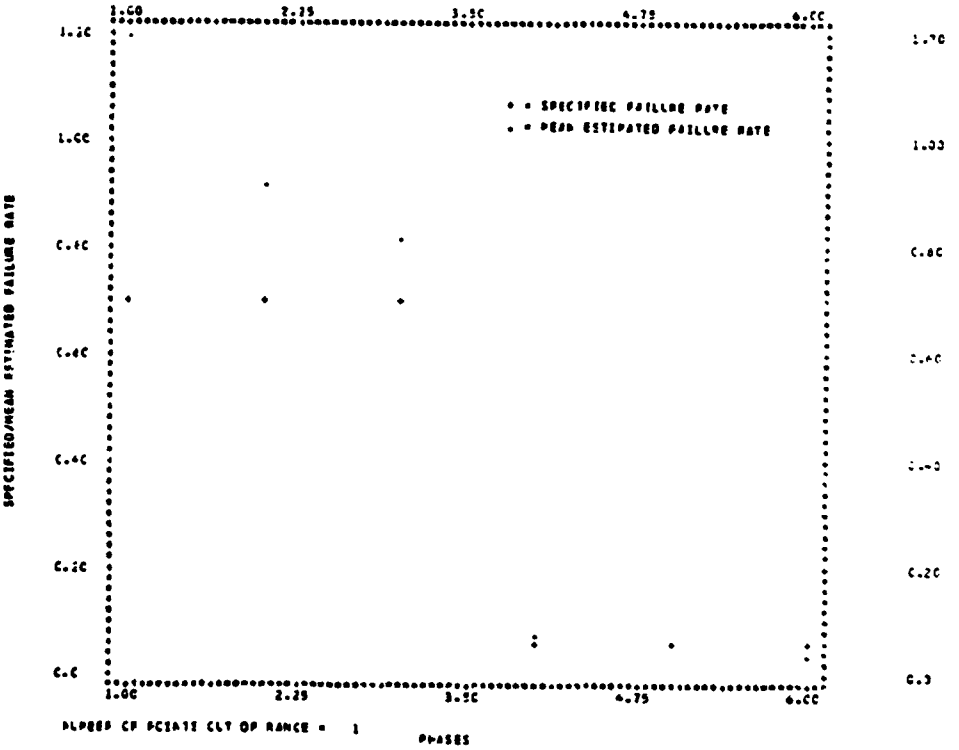
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2322	0.2322	0.2322	3.2504	3.2504	3.2504
MODEL ESTIMATE	17.6544	1.1887	0.9306	0.0661	0.0537	0.0455
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	2422.05	69.81	32.94	72.14	7.43	8.90
SAMPLE STD DEVIATION	********	1.0294	0.0296	0.0461	0.0234	0.0186
CUMULATIVE TEST TIME	2.134	4.277	6.418	36.133	66.232	96.210
CUMULATIVE FAILURES	1.5200	3.0300	4.5200	6.1400	7.5800	9.1300



CASE 10

20 ITEMS

PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2322	0.2327	0.2327	3.2504	3.2504	3.2504
MODEL ESTIMATE	1.2968	0.9132	0.8192	0.0769	0.0503	0.0423
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	79.54	30.46	17.03	53.77	0.66	15.47
SAMPLE STD DEVIATION	1.1801	0.5346	0.4100	0.0287	0.0174	0.0126
CUMULATIVE TEST TIME	4.250	8.535	12.829	72.919	133.073	193.287
CUMULATIVE FAILURES	3.1500	6.3100	9.2700	12.0800	15.0500	18.0600

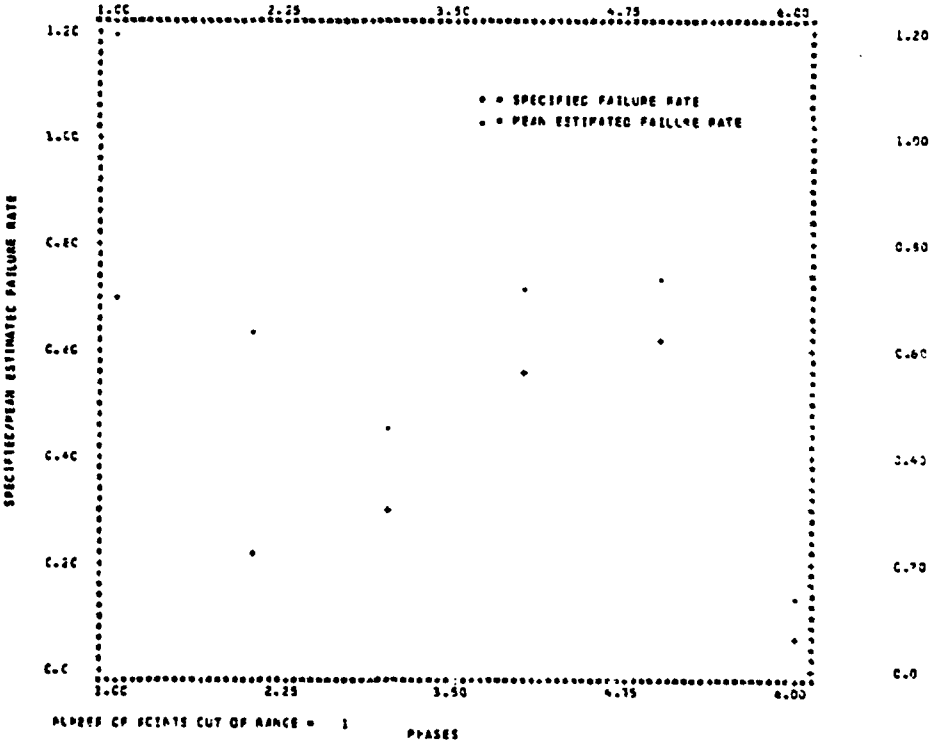


NUMBER OF POINTS OUT OF RANGE = 1

CASE 11

S .TEP:

PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.2250	0.3000	0.3500	C.e100	0.0500
PLANNED TEST TIME	0.2322	0.7223	0.5417	C.2955	C.2664	3.2504
MODEL ESTIMATE	2.1895	0.6307	0.4401	C.7253	C.7336	0.1368
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	212.79	180.33	93.38	30.06	2C.26	173.3?
SAMPLE STD DEVIATION	2.3593	0.7264	0.3505	C.8522	0.6498	0.0861
CUMULATIVE TEST TIME	1.061	4.334	6.850	8.174	9.398	24.311
CUMULATIVE FAILURES	C.6400	1.6CC0	2.3200	3.2300	4.0400	4.8203

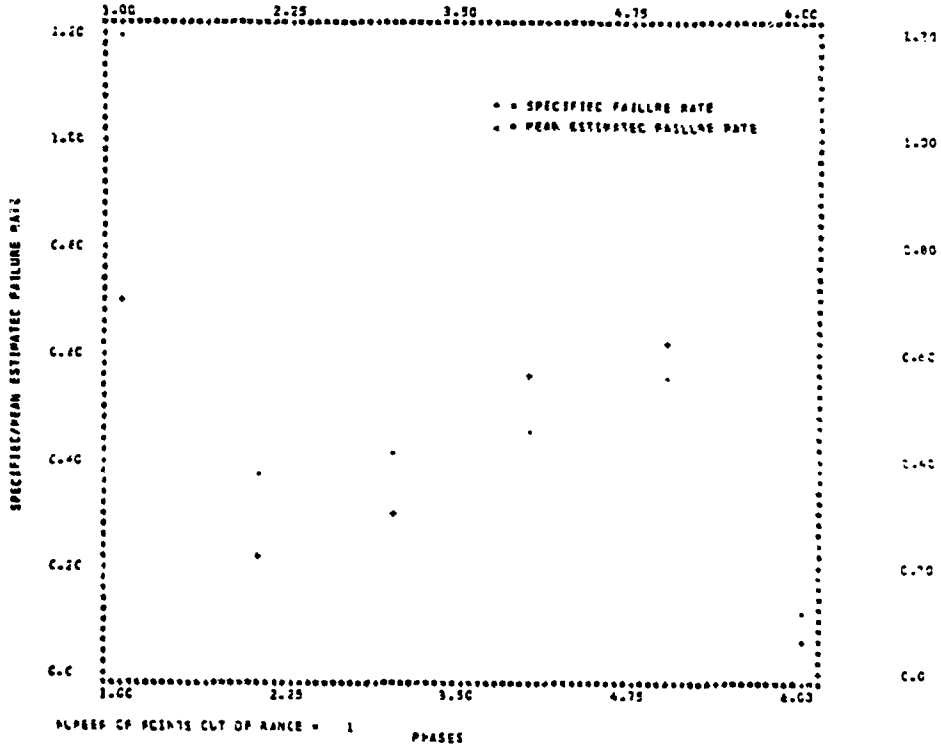


NUMBER OF POINTS OUT OF RANGE = 1

CASE 11

10 ITEMS

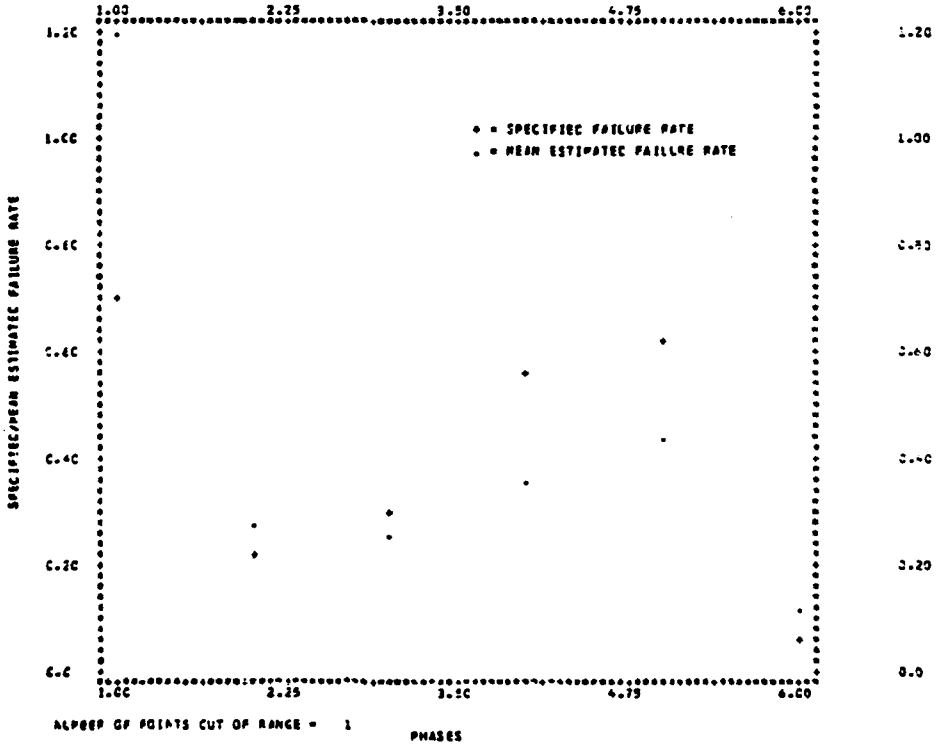
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.2250	0.3000	0.5500	0.6100	0.2500
PLANNED TEST TIME	0.2322	0.7223	0.9417	0.2595	0.2664	3.2504
MODEL ESTIMATE	1.5355	0.3774	0.4103	0.4614	0.5686	0.1256
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	119.36	67.73	36.78	16.11	6.88	131.23
SAMPLE STD DEVIATION	1.8078	0.3559	0.5967	0.3514	0.3702	0.0536
CUMULATIVE TEST TIME	2.152	8.799	13.780	16.489	18.896	48.642
CUMULATIVE FAILURES	1.3800	2.9400	4.5200	6.1000	7.6500	9.4600



CASE 11

20 ITEMS

PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.2250	0.3000	0.5500	0.6100	0.0500
PLANNED TEST TIME	0.2322	0.7223	0.5417	0.2955	0.2664	3.2504
MODEL ESTIMATE	1.2623	0.2759	0.2641	0.3507	0.4363	0.1140
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	80.33	22.61	11.96	36.24	28.47	127.98
SAMPLE STD DEVIATION	1.1929	0.1555	0.1284	0.1534	0.1742	0.0371
CUMULATIVE TEST TIME	4.305	17.622	27.723	33.145	38.013	97.852
CUMULATIVE FAILURES	2.9900	5.9900	8.8200	11.9700	15.3400	18.3400

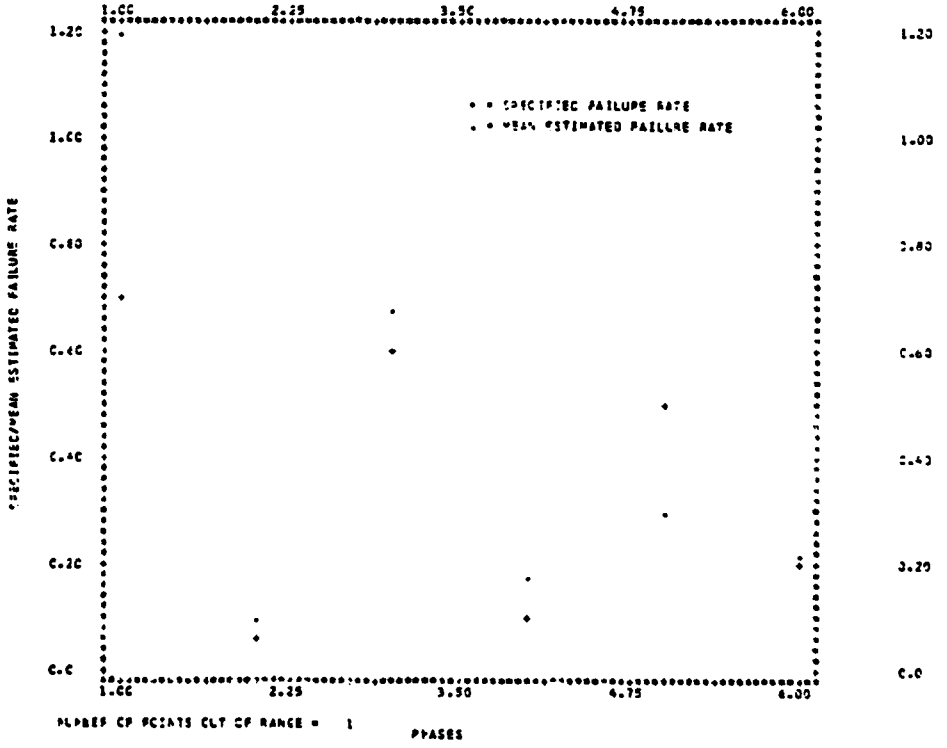


NUMBER OF POINTS OUT OF RANGE = 1

CASE 12

S [illegible]

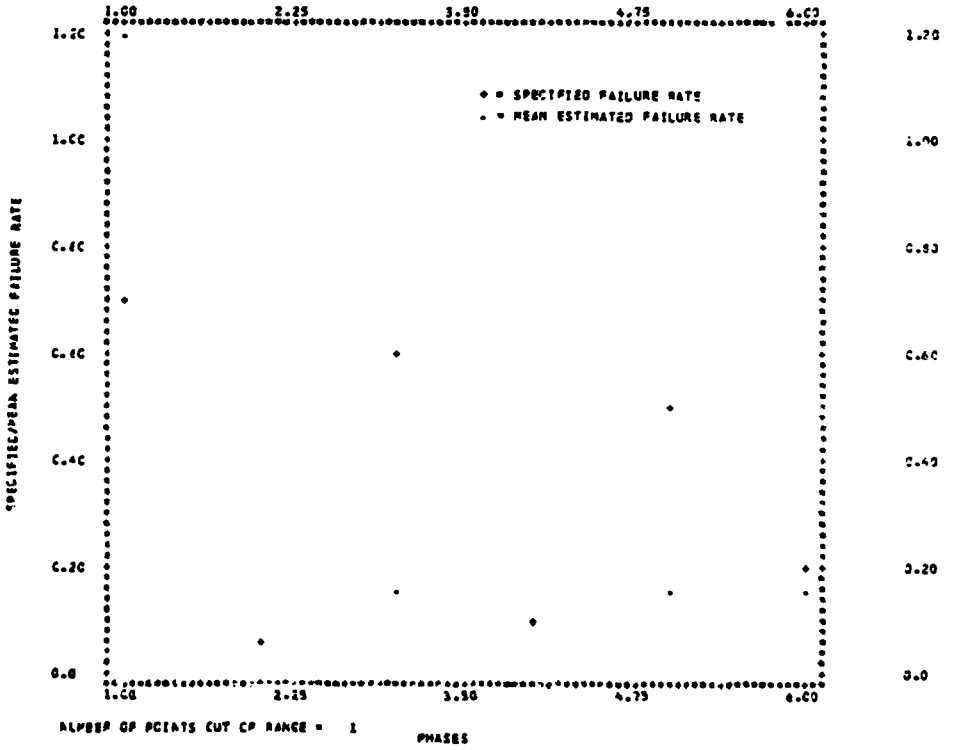
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.0500	0.6000	0.1000	0.5000	0.2000
PLANNED TEST TIME	0.2322	3.2504	0.2709	1.6252	0.3250	0.8126
MODEL ESTIMATE	2.6735	0.1042	0.6812	0.1809	0.3008	0.2121
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	281.93	108.45	13.54	80.87	39.85	6.04
SAMPLE STD DEVIATION	4.1245	0.1813	1.5503	0.1921	0.5044	0.1526
CUMULATIVE TEST TIME	1.071	15.454	17.191	24.740	26.225	30.031
CUMULATIVE FAILURES	0.6300	1.4600	2.3600	3.1000	3.8700	4.4700



CASE 12

10 ITEMS

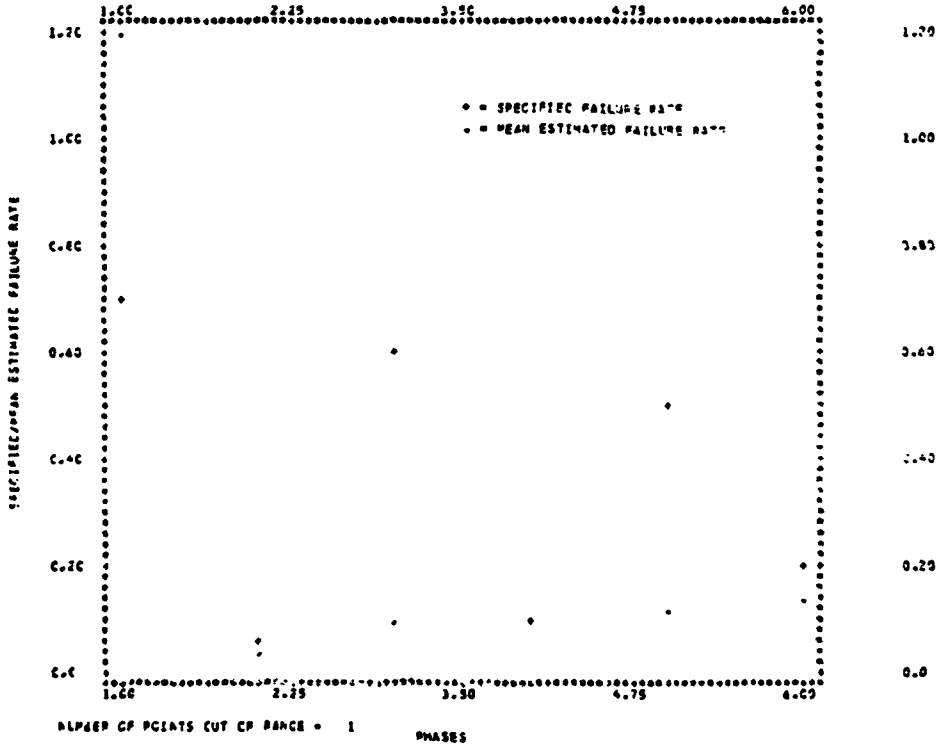
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.0500	0.6000	0.1000	0.5000	0.2000
PLANNED TEST TIME	0.2322	3.2504	0.2709	1.6252	0.3250	0.8126
ACCEL ESTIMATE	4.7415	0.0632	0.1653	0.1080	0.1536	0.1602
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	577.36	26.50	72.46	8.01	69.28	19.92
SAMPLE STD DEVIATION	24.3199	0.0610	0.2669	0.0750	0.1179	0.1070
CUMULATIVE TEST TIME	2.130	32.160	34.663	49.818	52.822	60.420
CUMULATIVE FAILURES	1.4300	2.9300	4.4600	5.8600	7.3600	8.7000



CASE 12

20 ITEMS

PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.0500	0.6000	0.1000	0.5000	0.2000
PLANNED TEST TIME	0.2322	3.2504	0.2709	1.6252	0.3250	0.8126
MODEL ESTIMATE	1.3544	0.0467	0.0941	0.0913	0.1258	0.1419
ESTIMATE BRACKETED AS PERCENTAGE OF ACTUAL FAILURE RATE	93.49	6.63	84.31	8.74	74.83	29.03
SAMPLE STD DEVIATION	1.5888	0.0296	0.0513	0.0426	0.0535	0.0610
CUMULATIVE TEST TIME	4.248	64.424	69.629	99.672	105.672	120.436
CUMULATIVE FAILURES	3.2700	6.1100	9.0400	12.1300	15.0400	18.0700



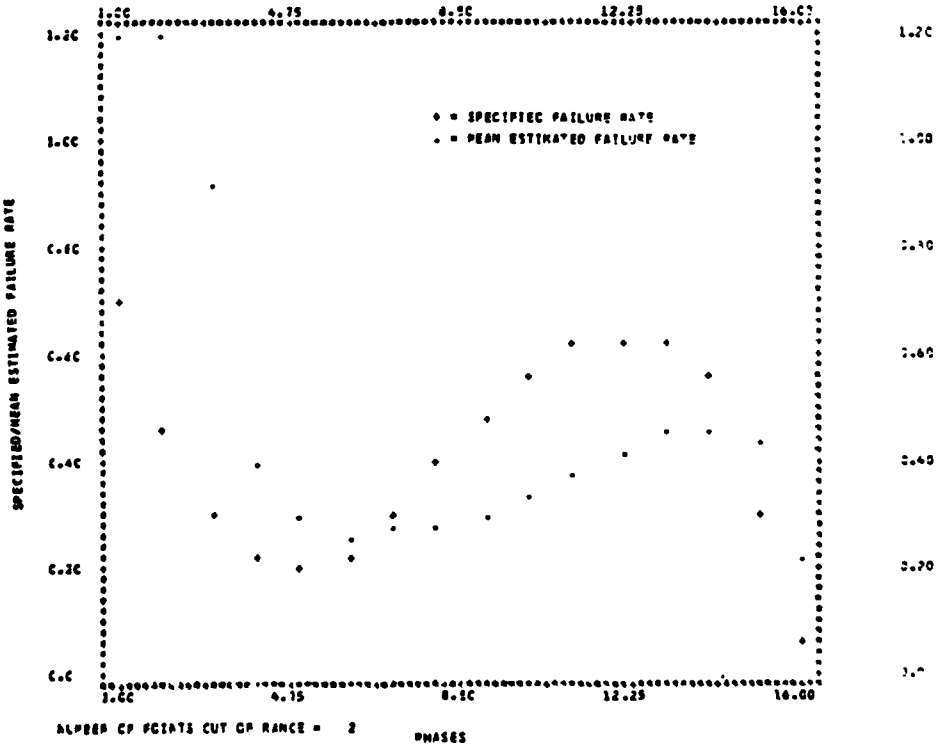
NUMBER OF POINTS CUT OF RANGE = 1

CASE 13

9 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.4500	0.3000	0.2250	0.2000	0.2250	0.3000	0.4500
PLANNED TEST TIME	0.2322	0.3612	0.5417	0.7223	0.8126	0.7223	0.5417	0.4063
MODEL ESTIMATE	2.1655	1.2619	0.9266	0.4025	0.3071	0.2629	0.2761	0.2785
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	209.36	187.10	208.88	78.89	53.55	16.83	7.98	38.78
SAMPLE STD DEVIATION	1.7129	1.2179	2.3761	0.3381	0.7777	0.1625	0.1523	0.1695
CUMULATIVE TEST TIME	1.084	2.747	5.213	8.521	19.284	15.637	16.136	29.056
CUMULATIVE FAILURES	0.5600	1.4300	2.2100	3.0500	3.7900	4.5000	5.2600	5.8700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4750	0.5500	0.6100	0.6250	0.6100	0.5500	0.3000	0.0500
PLANNED TEST TIME	0.3421	0.2955	0.2664	0.2600	0.2664	0.2955	0.5417	3.2534
MODEL ESTIMATE	0.2963	0.3387	0.3631	0.4242	0.4534	0.4689	0.4767	0.2776
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	37.62	38.42	37.20	32.12	24.85	14.75	45.57	345.21
SAMPLE STD DEVIATION	0.1803	0.2024	0.2230	0.2458	0.3160	0.2342	0.2118	0.0939
CUMULATIVE TEST TIME	21.665	23.016	24.225	25.423	26.636	27.556	30.517	45.555
CUMULATIVE FAILURES	6.4700	7.3000	8.1400	8.9600	9.7600	10.6100	11.3100	12.1000

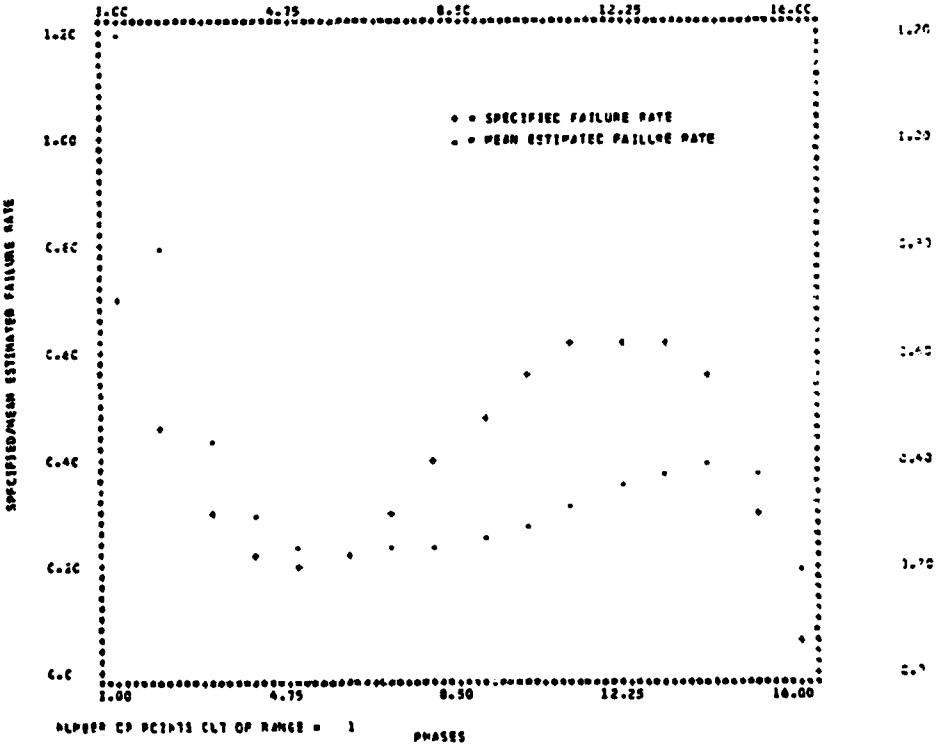


CASE 13

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.4500	0.3000	0.2250	0.2000	0.2250	0.3000	0.4000
PLANNED TEST TIME	0.2322	0.3612	0.5417	0.7223	0.8126	0.7223	0.5417	0.4063
MODEL ESTIMATE	2.0712	0.8055	0.4461	0.3011	0.2488	0.2260	0.2335	0.2442
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	195.89	79.00	48.71	33.84	24.39	0.45	22.15	38.95
SAMPLE STD DEVIATION	2.4201	0.9641	0.3452	0.1538	0.1085	0.0966	0.1015	0.0943
CUMULATIVE TEST TIME	2.114	5.466	13.457	17.116	24.621	31.344	36.371	40.172
CUMULATIVE FAILURES	1.5600	3.2400	4.6000	6.1800	7.7400	9.1100	10.4900	11.7600

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4750	0.5500	0.6100	0.6250	0.6100	0.5500	0.3500	0.0500
PLANNED TEST TIME	0.3421	0.2555	0.2064	0.2030	0.2064	0.2555	0.5417	3.7804
MODEL ESTIMATE	0.2631	0.2833	0.3187	0.3502	0.3770	0.3585	0.3986	0.1969
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	44.61	48.49	47.75	43.97	38.20	27.55	29.52	293.81
SAMPLE STD DEVIATION	0.1144	0.1052	0.1199	0.1297	0.1384	0.1458	0.1446	0.0966
CUMULATIVE TEST TIME	43.361	46.123	48.581	50.967	53.426	56.146	61.066	91.349
CUMULATIVE FAILURES	13.0500	14.3800	16.0100	17.6000	19.1480	20.6300	22.2300	23.9800

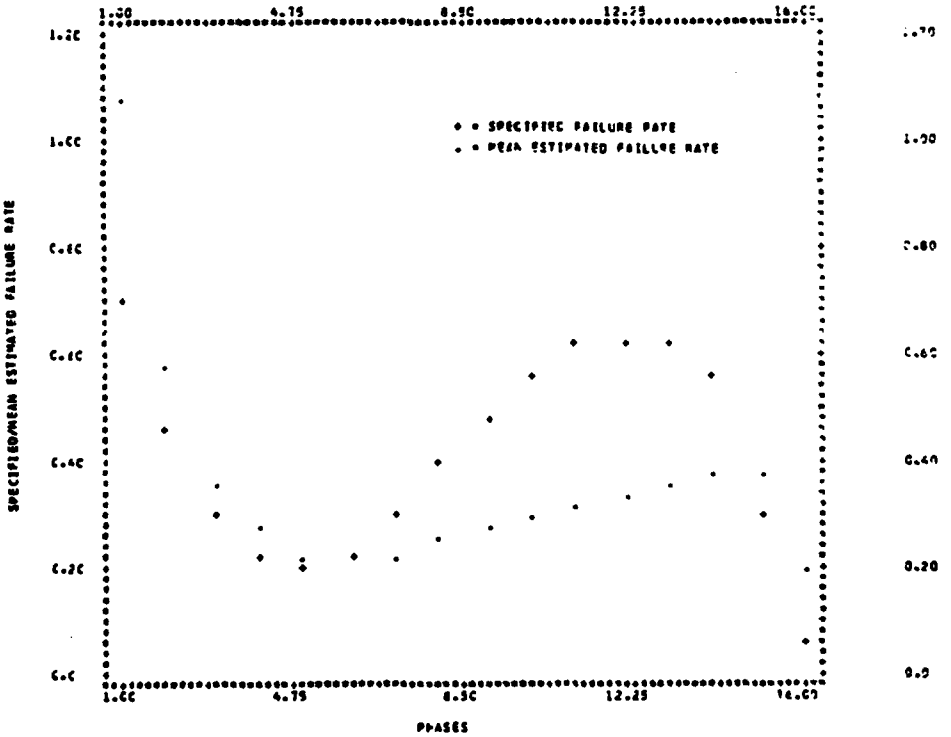


CASE 13

20 ITERS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.4500	0.3000	0.2250	0.2000	0.2250	0.3333	0.4000
PLANNED TEST TIME	0.2322	0.3612	0.5417	0.7223	0.8126	0.7223	0.5417	0.4064
MODEL ESTIMATE	1.0814	0.9749	0.3574	0.2743	0.2243	0.2144	0.2286	0.2926
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	54.48	27.75	19.15	21.93	12.13	4.70	23.76	37.26
SAMPLE STD DEVIATION	0.8251	0.3507	0.1342	0.1061	0.0731	0.0767	0.0803	0.0810
CUMULATIVE TEST TIME	4.285	10.655	21.010	34.271	49.286	62.670	72.571	80.027
CUMULATIVE FAILURES	3.0100	5.4500	8.8700	12.0200	15.0100	18.0000	21.1700	24.2300

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4750	0.5500	0.6100	0.6250	0.6100	0.5500	0.3000	0.0930
PLANNED TEST TIME	0.3421	0.2655	0.2064	0.2000	0.2064	0.2655	0.5417	3.2504
MODEL ESTIMATE	0.2736	0.2985	0.3251	0.3494	0.3697	0.3853	0.3794	0.2014
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	42.41	45.72	46.71	44.10	39.39	29.23	26.48	302.73
SAMPLE STD DEVIATION	0.0937	0.0859	0.0677	0.0921	0.0906	0.0874	0.0813	0.0387
CUMULATIVE TEST TIME	86.320	91.794	98.751	101.574	106.504	111.591	121.865	182.120
CUMULATIVE FAILURES	27.1300	30.0800	33.0600	35.9700	38.8100	41.5000	45.1200	47.9900

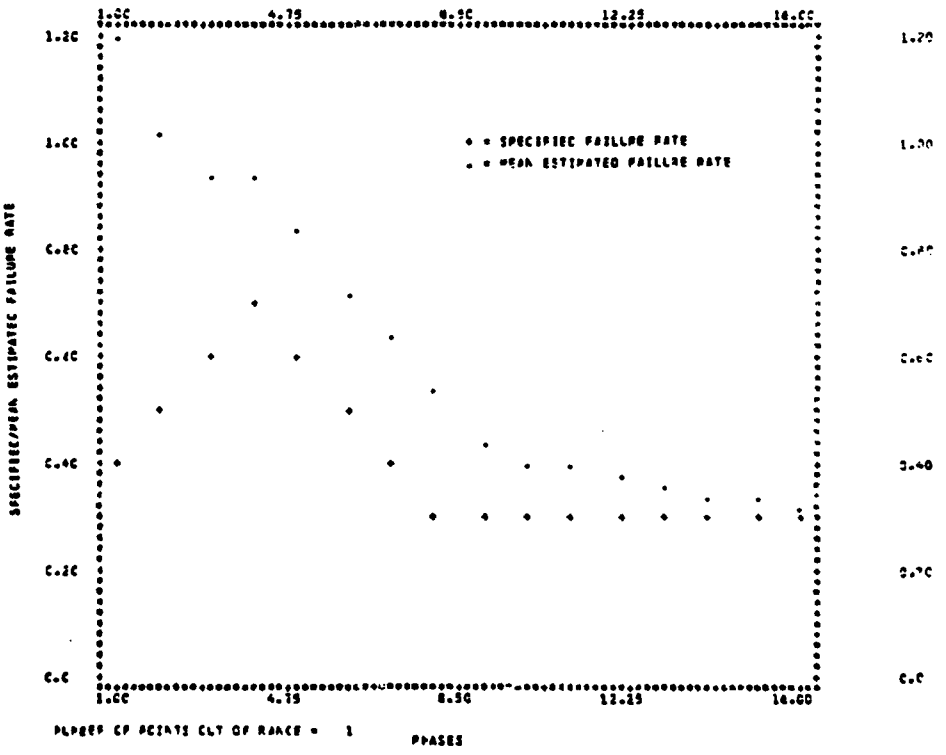


CASE 14

8 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.4000	0.5000
PLANNED TEST TIME	0.4063	0.3250	0.2709	0.2322	0.2709	0.3250	0.4063	0.5417
MODEL ESTIMATE	1.2017	1.0294	0.9462	0.9438	0.8370	0.7277	0.6429	0.5972
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	200.44	105.88	57.71	34.83	19.50	45.54	60.72	79.05
SAMPLE STD DEVIATION	0.8653	1.0344	0.9428	0.8915	0.6107	0.4619	0.3960	0.3277
CUMULATIVE TEST TIME	1.501	3.419	4.675	5.754	7.016	8.522	10.397	12.878
CUMULATIVE FAILURES	0.8300	1.3300	2.0700	2.8100	3.5400	4.2100	5.0700	5.8000

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
PLANNED TEST TIME	0.5417	0.5417	0.5417	0.5417	0.5417	0.5417	0.5417	0.5417
MODEL ESTIMATE	0.4457	0.4034	0.3646	0.3751	0.3512	0.3365	0.3312	0.3197
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	48.56	34.47	31.52	25.02	17.06	12.20	10.40	6.57
SAMPLE STD DEVIATION	0.2358	0.2051	0.1658	0.1731	0.1414	0.1304	0.1269	0.1180
CUMULATIVE TEST TIME	15.418	17.419	20.376	22.657	25.381	27.685	30.394	32.911
CUMULATIVE FAILURES	6.4400	7.1700	8.0500	8.8100	9.4800	10.1400	10.9100	11.5700

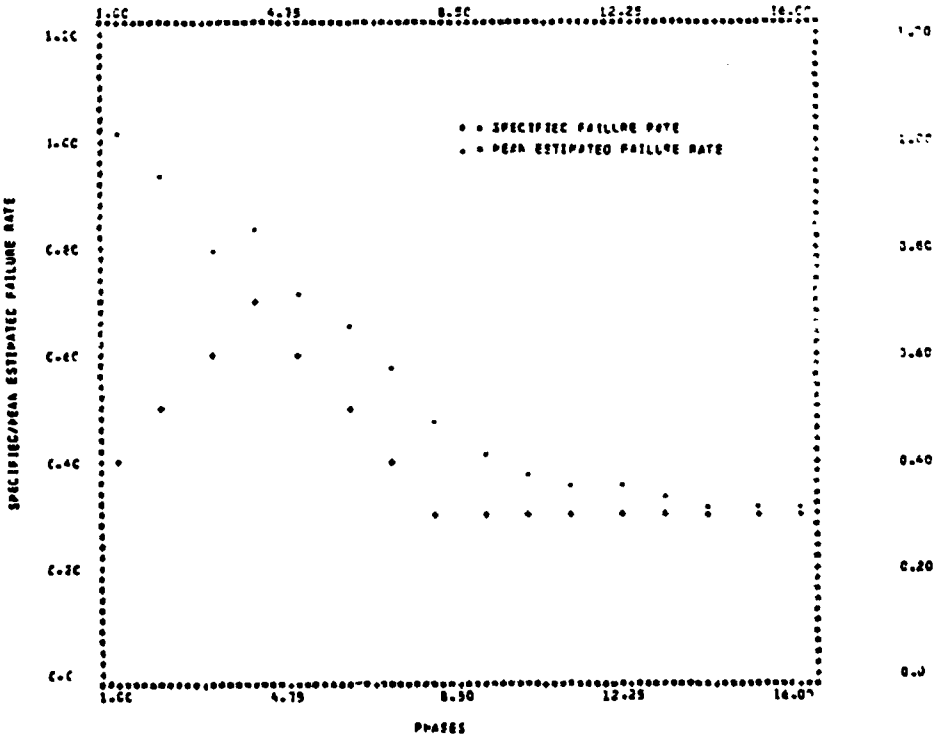


CASE 14

10 STEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000	0.4000	0.3000
PLANNED TEST TIME	0.4063	0.3750	0.2709	0.2322	0.2709	0.3250	0.4063	0.5417
MODEL ESTIMATE	1.0249	0.9329	0.7954	0.8310	0.7100	0.6545	0.5741	0.4804
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	156.23	86.57	32.57	18.71	18.33	37.91	43.53	60.1[illegible]
SAMPLE STD DEVIATION	1.1811	0.8713	0.4491	0.4529	0.3486	0.3173	0.2776	0.2097
CUMULATIVE TEST TIME	3.748	6.722	9.225	11.362	13.907	16.516	20.662	25.665
CUMULATIVE FAILURES	1.5500	3.2000	4.7400	6.3500	7.5400	8.9400	10.4000	11.4200

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.2000	0.3000
PLANNED TEST TIME	0.5417	0.5417	0.5417	0.5417	0.5417	0.5417	0.5417	0.5417
MODEL ESTIMATE	0.4192	0.3746	0.3629	0.3511	0.3335	0.3275	0.3236	0.3170
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	39.74	24.87	20.96	17.03	11.17	9.16	7.85	5.99
SAMPLE STD DEVIATION	0.1591	0.1346	0.1224	0.1043	0.0947	0.0857	0.0848	0.0819
CUMULATIVE TEST TIME	30.791	35.758	40.712	45.666	50.700	55.666	60.678	65.682
CUMULATIVE FAILURES	13.3500	14.6700	16.3000	17.9000	19.9100	20.9100	22.4500	23.9800

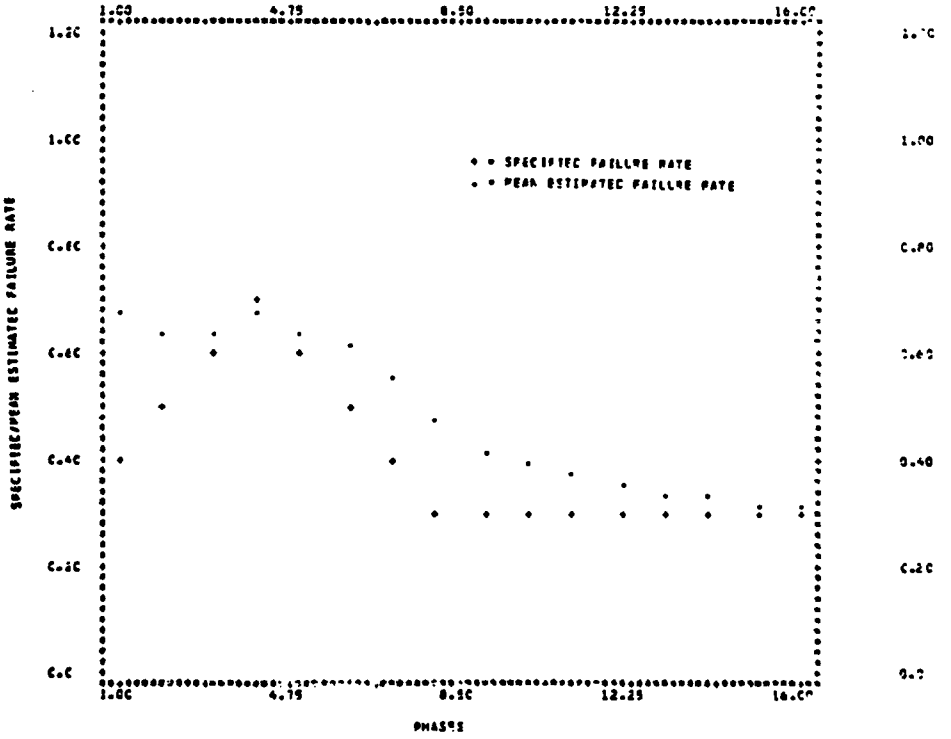


CASE 14

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.4000	0.5000	0.6000	0.7000	0.8000	0.5000	0.4000	0.3333
PLANNED TEST TIME	0.4063	0.3250	0.2709	0.2322	0.2705	0.3250	0.4063	0.5417
MODEL ESTIMATE	0.6868	0.6447	0.6330	0.6711	0.6484	0.6114	0.5569	0.4782
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	71.69	28.93	5.49	4.13	8.06	22.29	39.23	56.39
SAMPLE STD DEVIATION	0.5358	0.4113	0.2714	0.2612	0.2510	0.1863	0.1641	0.1258
CUMULATIVE TEST TIME	7.471	13.447	18.470	22.792	27.821	33.614	41.254	51.174
CUMULATIVE FAILURES	3.1300	6.2100	9.0700	11.8200	14.5800	17.4400	20.8200	24.1000

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
PLANNED TEST TIME	0.5417	0.5417	0.5417	0.5417	0.5417	0.5417	0.5417	0.5417
MODEL ESTIMATE	0.4262	0.3918	0.3705	0.3522	0.3414	0.3312	0.3224	0.3140
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	42.08	30.61	23.50	17.41	13.81	10.39	7.48	5.39
SAMPLE STD DEVIATION	0.1045	0.0925	0.0846	0.0719	0.0686	0.0643	0.0627	0.0651
CUMULATIVE TEST TIME	61.120	71.108	81.071	91.080	101.031	110.672	120.579	130.996
CUMULATIVE FAILURES	27.1500	30.1500	33.2400	36.1800	39.2700	42.2000	45.1700	48.0500

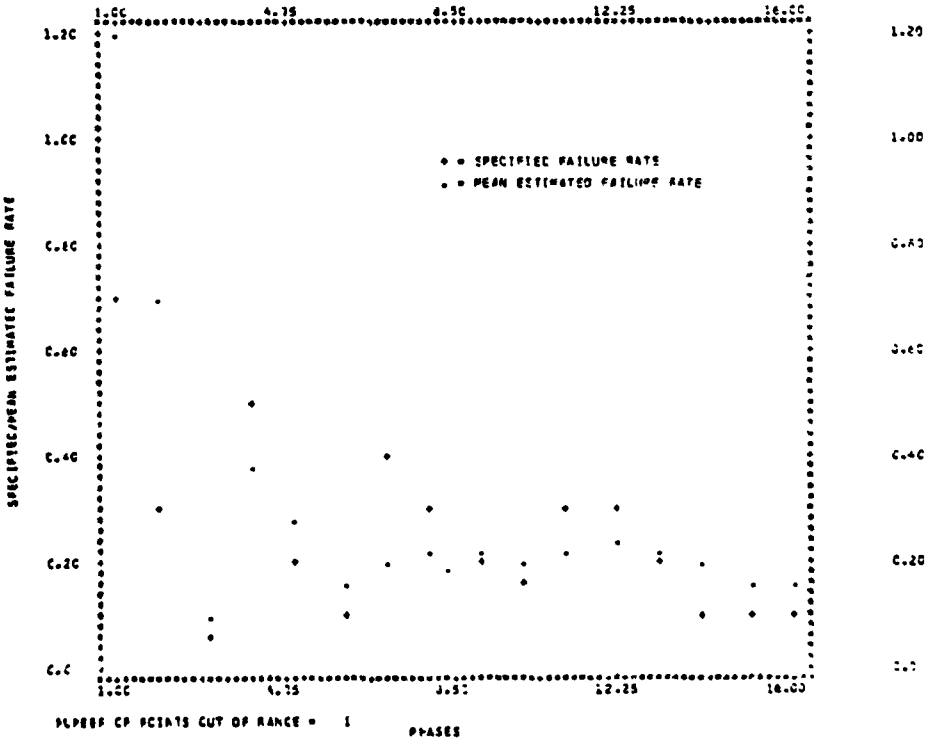


CASE 15

STATS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.3000	0.0500	C.5000	C.2000	C.1CC0	0.4C00	0.3000
PLANNED TEST TIME	0.2322	0.5417	3.2504	C.3250	C.5124	1.e252	0.4C63	0.5417
MODEL ESTIMATE	43.2422	0.6972	0.1078	C.3765	0.2858	0.1635	0.1510	0.2181
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	6077.46	132.40	115.52	24.71	42.89	63.54	62.26	27.31
SAMPLE STD DEVIATION	*******	0.6149	0.1108	C.7281	C.3788	0.1745	0.1773	0.2238
CUMULATIVE TEST TIME	1.C74	3.573	18.481	19.99C	23.722	31.225	33.112	35.575
CUMULATIVE FAILURES	0.7500	1.9300	2.2500	2.9500	3.7600	4.52C0	5.14C0	5.6300

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	C.2000	0.1500	0.3000	C.3000	C.2000	0.1000	0.1CCC	0.1C00
PLANNED TEST TIME	0.8126	1.6835	0.5417	C.5417	C.8126	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.2127	0.2C11	0.2208	C.2304	0.2295	0.1959	0.1686	0.1518
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	6.35	34.08	26.39	23.19	14.76	95.88	68.59	51.81
SAMPLE STD DEVIATION	0.1944	0.1587	0.1710	C.1586	0.1455	0.1124	0.C865	0.C777
CUMULATIVE TEST TIME	39.351	44.288	46.786	49.254	53.005	60.484	66.057	75.729
CUMULATIVE FAILURES	6.6500	7.5C00	8.3100	9.1700	9.5C0C	10.71C0	11.35C0	11.55C0

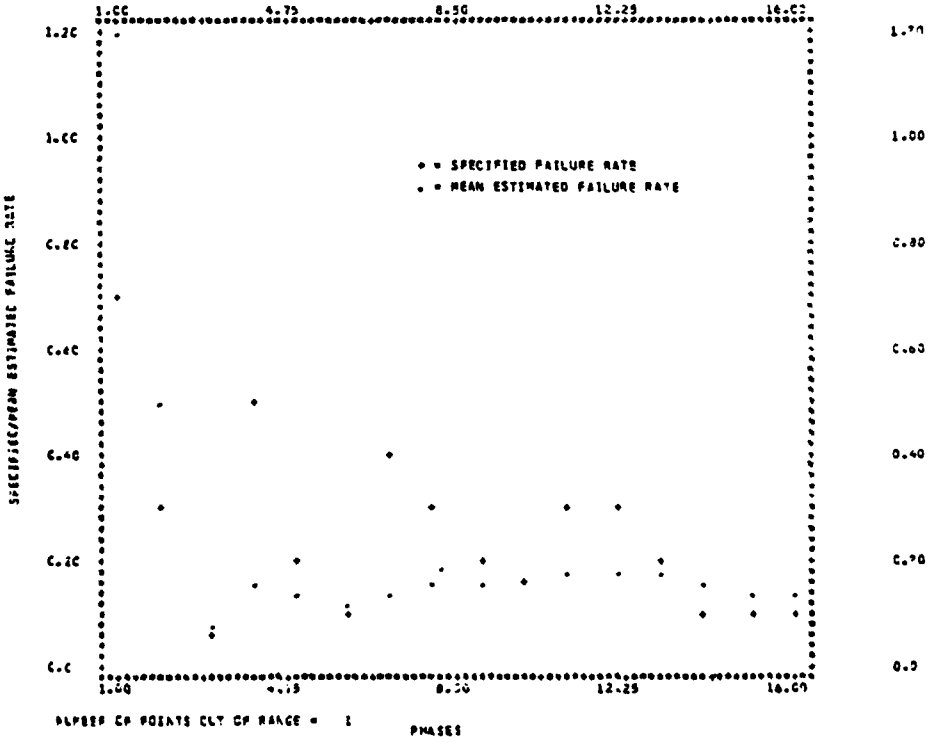


CASE 15

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.3000	0.0500	0.5000	0.2000	0.1000	0.4000	0.3000
PLANNED TEST TIME	0.2322	0.5417	3.2504	0.3750	0.8126	1.6252	0.4063	0.5417
MODEL ESTIMATE	1.6614	0.4541	0.0789	0.1567	0.1448	0.1105	0.1385	0.1541
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	137.34	64.68	57.86	68.67	27.61	10.47	65.36	48.65
SAMPLE STD DEVIATION	1.6267	0.5024	0.1076	0.3366	0.1564	0.0636	0.0857	0.0777
CUMULATIVE TEST TIME	2.104	7.083	37.101	40.105	47.606	62.578	66.304	71.262
CUMULATIVE FAILURES	1.7700	3.3500	4.8900	6.3500	7.9200	9.3800	10.9800	12.5500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.2000	0.1500	0.3000	0.3000	0.2000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.8126	1.0835	0.5417	0.5417	0.8126	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.1600	0.1580	0.1742	0.1838	0.1828	0.1622	0.1499	0.1411
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	19.98	5.31	41.54	38.74	8.60	62.15	49.85	41.12
SAMPLE STD DEVIATION	0.0893	0.0838	0.0939	0.0920	0.0822	0.0667	0.0547	0.0529
CUMULATIVE TEST TIME	76.788	88.725	93.707	98.702	106.248	121.305	136.257	151.152
CUMULATIVE FAILURES	13.9900	15.5700	17.1600	18.6600	20.1100	21.6400	23.2900	24.8700

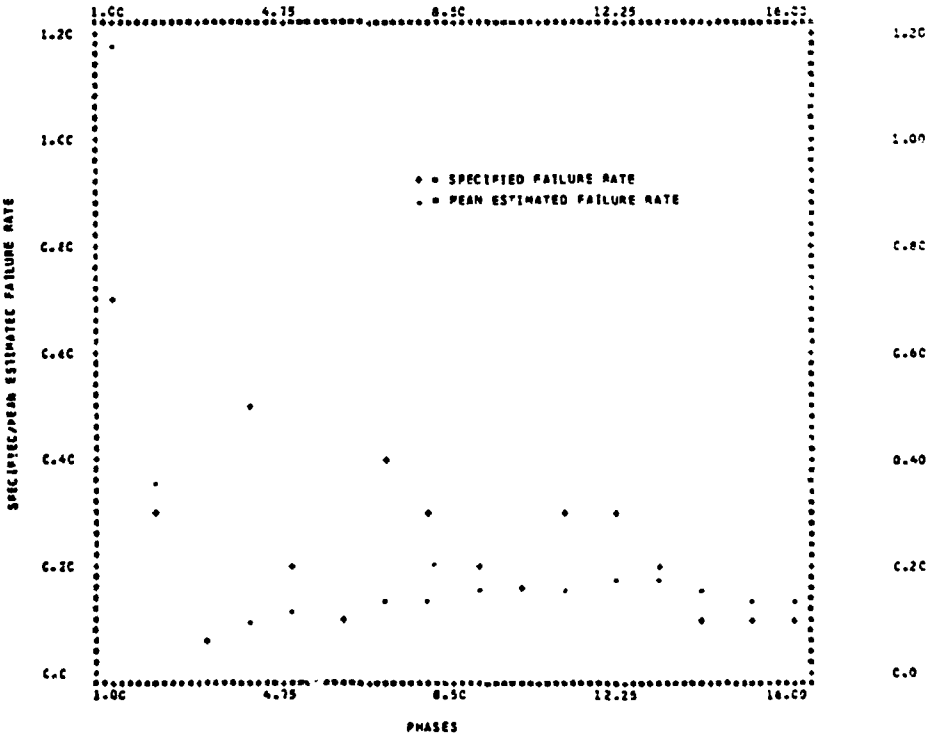


CASE 15

20 TIERS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.3000	0.0500	0.5000	0.2000	0.1000	0.4000	0.3000
PLANNED TEST TIME	0.2322	0.5417	3.2504	0.3250	0.8126	1.6252	0.4063	0.5417
MODEL ESTIMATE	1.1828	0.3503	0.0600	0.0928	0.1123	0.1035	0.1308	0.1530
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	68.98	16.77	19.92	81.45	43.85	3.46	67.30	50.0[illegible]
SAMPLE STD DEVIATION	1.3276	0.1567	0.0259	0.0401	0.0442	0.0367	0.0493	0.0519
CUMULATIVE TEST TIME	4.272	14.288	74.066	80.098	95.034	124.911	132.346	142.278
CUMULATIVE FAILURES	2.9900	5.8500	9.0000	11.7600	14.8800	18.0500	21.3200	24.4900

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.2000	0.1500	0.3000	0.3000	0.2000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.8126	1.0835	0.5417	0.5417	0.8126	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.1560	0.1532	0.1658	0.1800	0.1817	0.1631	0.1479	0.1378
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	22.01	2.10	44.73	40.01	9.15	63.13	47.89	37.79
SAMPLE STD DEVIATION	0.0518	0.0465	0.0486	0.0463	0.0456	0.0410	0.0332	0.0301
CUMULATIVE TEST TIME	157.243	177.242	187.247	197.196	212.194	242.173	272.298	302.306
CUMULATIVE FAILURES	27.4000	30.4300	33.4100	36.6600	39.6100	42.6600	45.6900	48.4300

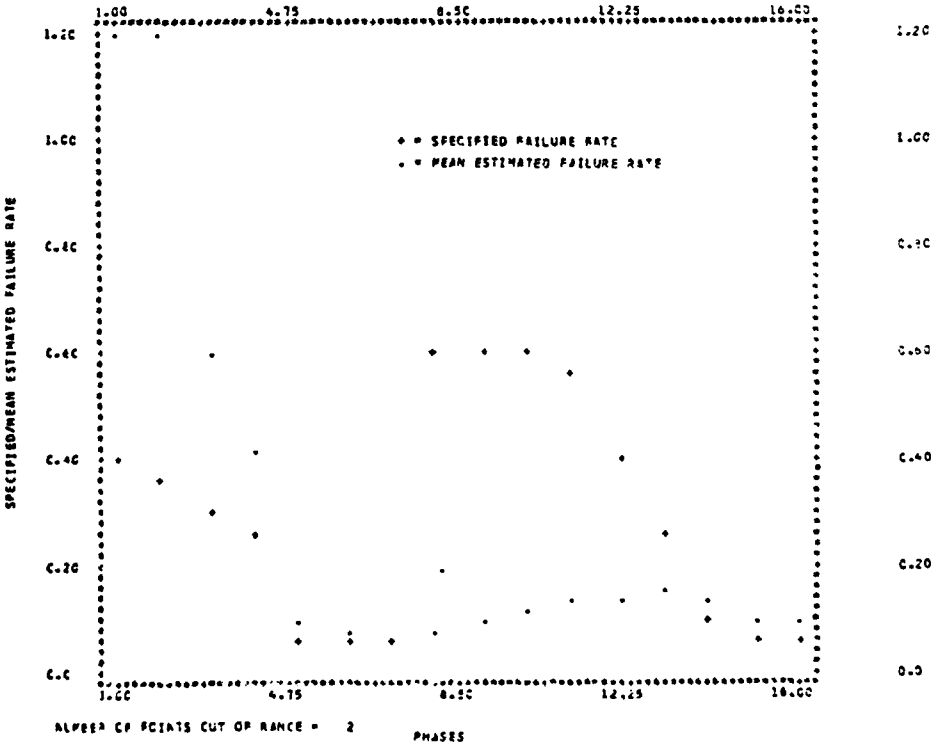


CASE 16

9 STEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.4000	0.3500	0.3000	0.2500	0.0500	0.0500	0.0500	0.4000
PLANNED TEST TIME	0.4063	0.4643	0.5417	0.6501	3.2504	3.2504	3.2504	0.2709
MODEL ESTIMATE	2.2716	2.3319	0.5924	0.4192	0.1090	0.0749	0.0596	0.0749
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	467.91	566.25	97.46	67.66	118.06	49.76	19.25	87.52
SAMPLE STD DEVIATION	4.7638	12.3516	0.5611	0.2692	0.0689	0.0458	0.0371	0.0400
CUMULATIVE TEST TIME	1.878	3.569	6.457	9.450	24.581	39.528	54.650	55.895
CUMULATIVE FAILURES	0.6300	1.6700	2.3800	3.1900	3.9200	4.6500	5.4300	6.1700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.6000	0.6000	0.5500	0.4000	0.2500	0.1000	0.0500	0.0500
PLANNED TEST TIME	0.2709	0.2709	0.2955	0.4063	0.6501	1.6252	3.2504	3.2504
MODEL ESTIMATE	0.0907	0.1168	0.1339	0.1486	0.1601	0.1640	0.1097	0.0910
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	84.89	80.53	75.65	62.86	35.97	42.99	119.38	81.99
SAMPLE STD DEVIATION	0.0534	0.0828	0.0829	0.0892	0.0994	0.0793	0.0512	0.0403
CUMULATIVE TEST TIME	57.150	58.270	59.730	61.603	64.563	72.116	87.265	102.556
CUMULATIVE FAILURES	6.8500	7.7700	8.5000	9.2300	10.0100	10.6900	11.3100	11.9300

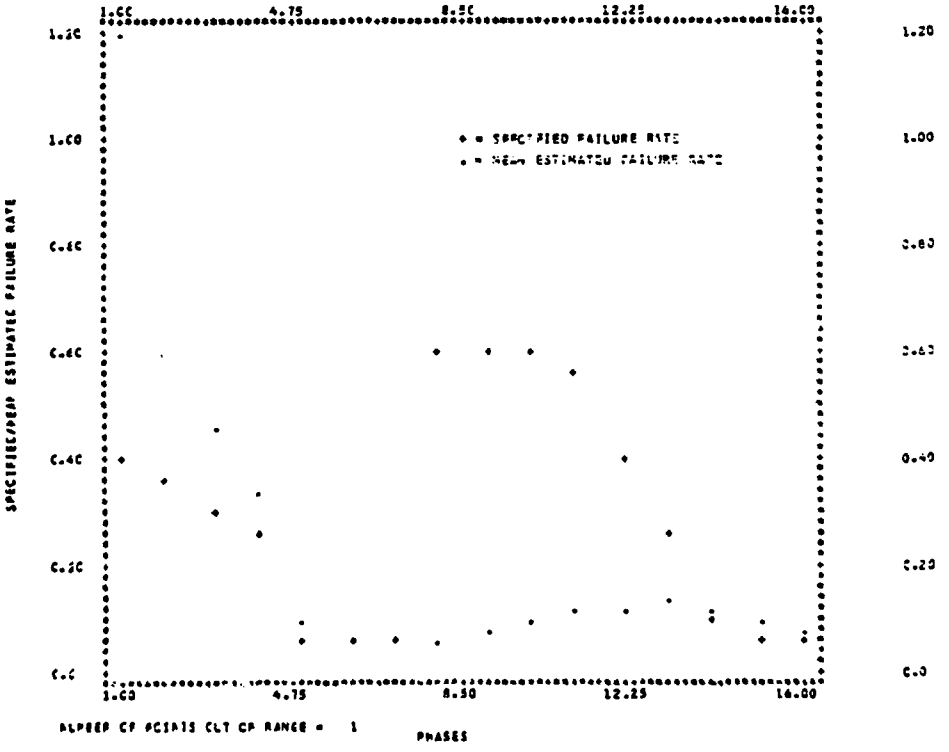


CASE 16

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.4000	0.3500	0.3000	0.2500	0.0500	0.0500	0.0500	0.4000
PLANNED TEST TIME	0.4063	0.4443	0.5417	0.6501	3.2504	3.2504	3.2504	0.2709
MODEL ESTIMATE	1.3927	0.6009	0.4457	0.3459	0.1024	0.0667	0.0523	0.0645
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	248.18	71.69	55.24	38.35	104.88	33.44	4.66	85.24
SAMPLE STD DEVIATION	2.2082	0.4355	0.2504	0.1796	0.0450	0.0263	0.0184	0.0246
CUMULATIVE TEST TIME	3.724	7.987	12.941	18.954	48.668	78.729	108.938	111.465
CUMULATIVE FAILURES	1.6400	3.2700	4.9400	6.4400	8.0500	9.4600	10.7700	12.1100

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.6000	0.6000	0.5500	0.4000	0.2500	0.1000	0.0500	0.0500
PLANNED TEST TIME	0.2709	0.2709	0.2955	0.4063	0.6501	1.6252	3.2504	3.2504
MODEL ESTIMATE	0.0791	0.0560	0.1133	0.1264	0.1347	0.1240	0.1011	0.0670
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	86.81	84.00	79.40	68.41	46.12	24.04	102.18	73.95
SAMPLE STD DEVIATION	0.0286	0.0357	0.0409	0.0431	0.0438	0.0386	0.0263	0.0220
CUMULATIVE TEST TIME	113.966	116.459	119.164	122.893	128.903	144.121	173.911	203.609
CUMULATIVE FAILURES	13.6500	15.2600	16.8700	18.3700	19.8300	21.1000	22.6700	24.1600

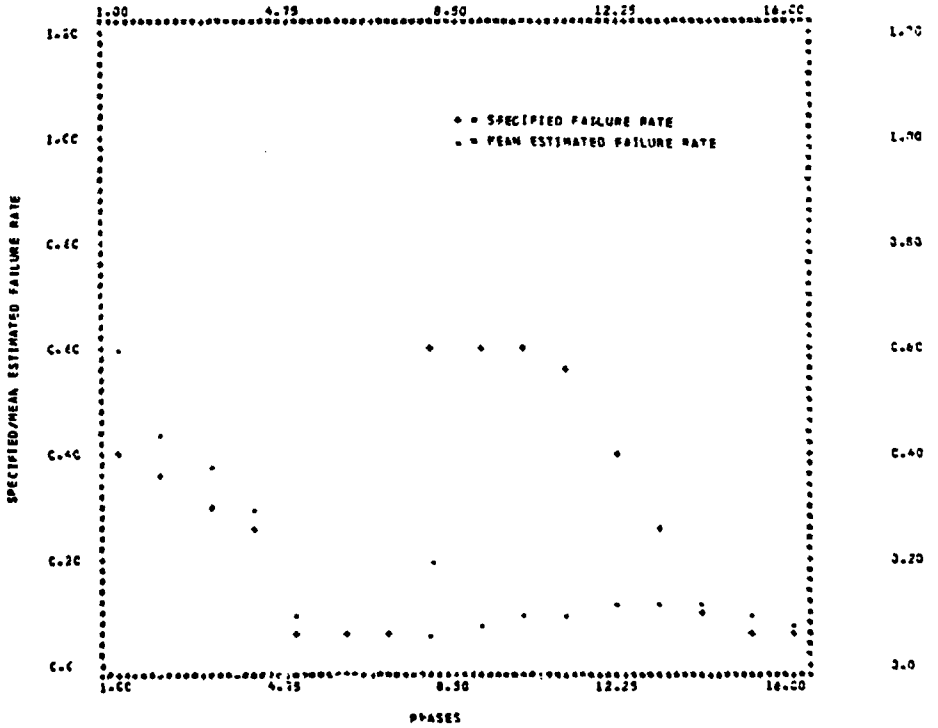


CASE 16

20 :TE::

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.4000	0.3500	0.3000	0.2500	0.0500	0.0500	0.0500	0.6000
PLANNED TEST TIME	0.4063	0.4643	0.5417	0.6501	3.2504	3.2504	3.2504	0.2709
MODEL ESTIMATE	0.5997	0.4452	0.3736	0.3096	0.0908	0.0618	0.0506	0.0637
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	49.92	27.19	24.54	23.82	81.51	23.62	1.18	89.38
SAMPLE STD DEVIATION	0.4130	0.2385	0.1584	0.1179	0.0316	0.0183	0.0146	0.0176
CUMULATIVE TEST TIME	7.498	16.057	26.036	38.054	58.274	158.310	218.639	223.662
CUMULATIVE FAILURES	3.0000	6.1600	9.3600	12.3800	15.1900	18.1500	20.9800	23.9300

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.6000	0.6000	0.5500	0.4000	0.2500	0.1000	0.0500	0.0500
PLANNED TEST TIME	0.2709	0.2709	0.2955	0.4063	0.6501	1.6252	3.2504	3.2504
MODEL ESTIMATE	0.3767	0.0905	0.1064	0.1189	0.1266	0.1150	0.0968	0.0840
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	87.21	84.92	80.66	70.26	49.36	18.58	93.37	67.92
SAMPLE STD DEVIATION	0.0193	0.0218	0.0258	0.0276	0.0297	0.0268	0.0209	0.0168
CUMULATIVE TEST TIME	226.696	233.718	239.165	246.732	258.833	285.011	346.562	408.775
CUMULATIVE FAILURES	26.7100	29.5700	32.6700	35.5200	38.2600	41.0500	43.9100	46.9500

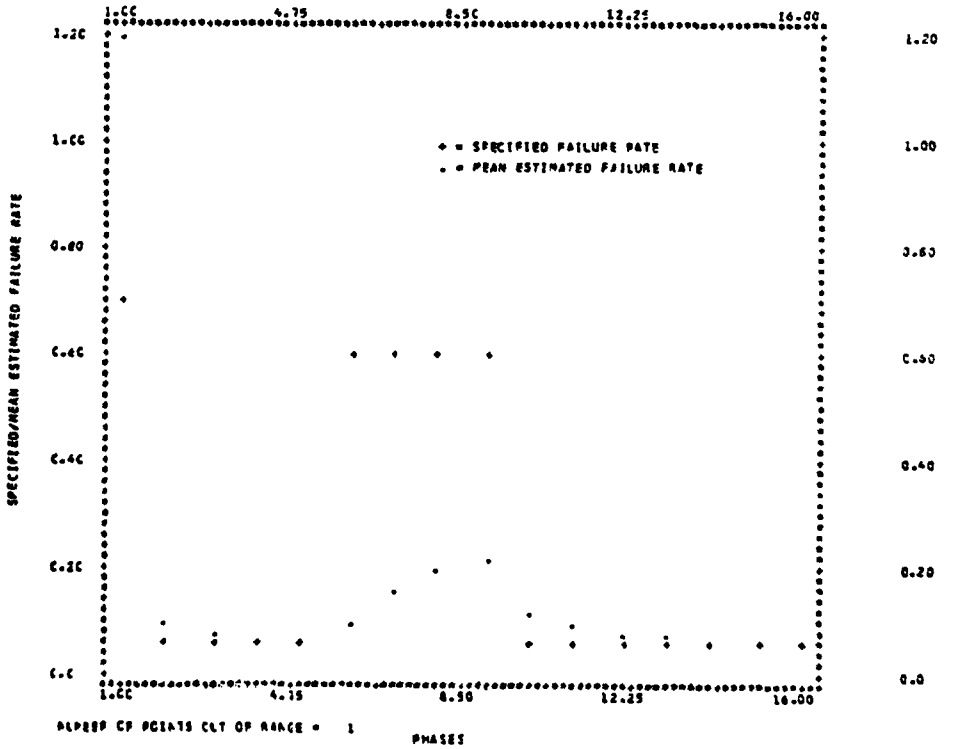


CASE 17

5 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.0500	0.0500	0.0500	0.0500	0.6000	0.6000	0.6000
PLANNED TEST TIME	0.2322	3.2504	3.2504	3.2504	3.2504	0.2709	0.2709	0.2709
MODEL ESTIMATE	3.1219	0.1046	0.0767	0.0553	0.0540	0.1088	0.1657	0.2002
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	345.68	109.30	53.34	10.56	7.96	81.87	72.35	66.64
SAMPLE STD DEVIATION	4.3345	0.1278	0.1014	0.0368	0.0371	0.1726	0.3576	0.4368
CUMULATIVE TEST TIME	1.074	16.100	31.132	46.164	61.089	62.342	63.584	64.847
CUMULATIVE FAILURES	0.7300	1.4500	2.4000	3.1800	3.9800	4.7500	5.5600	6.2300

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.6000	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2709	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.2253	0.1140	0.0939	0.0803	0.0722	0.0690	0.0672	0.0632
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	62.44	128.08	87.77	60.56	44.43	37.91	34.27	26.31
SAMPLE STD DEVIATION	0.4564	0.0769	0.0561	0.0404	0.0328	0.0311	0.0297	0.0258
CUMULATIVE TEST TIME	66.090	81.203	95.926	110.912	125.809	140.723	155.588	170.701
CUMULATIVE FAILURES	7.0100	7.7100	8.5400	9.2800	10.0300	10.8300	11.7400	12.4900

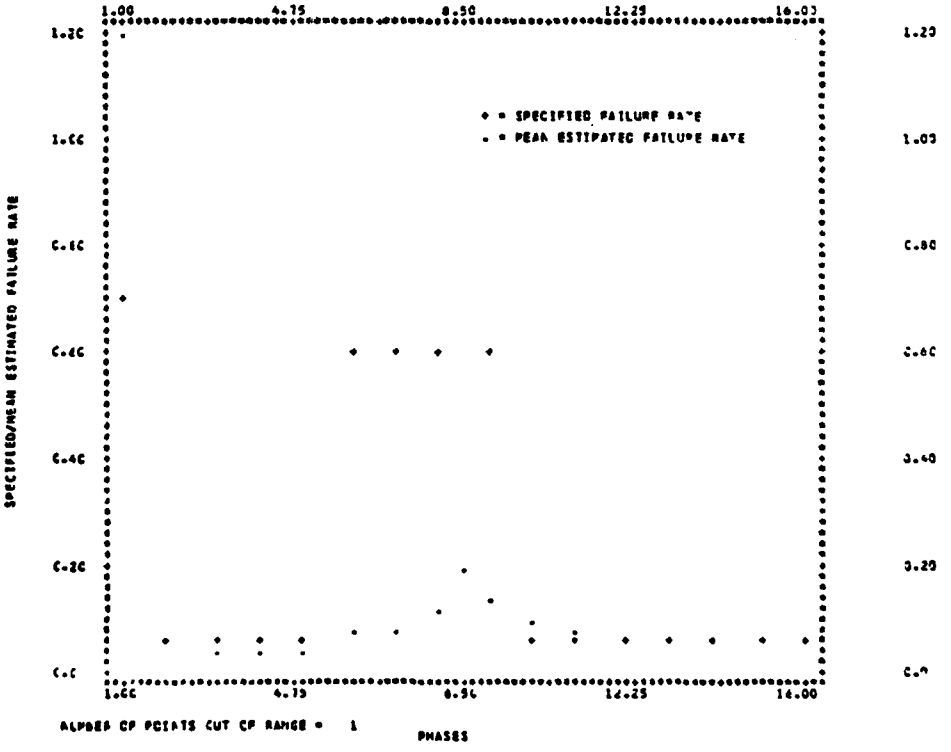


CASE 17

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2322	3.2504	3.2504	3.2504	3.2504	0.2709	0.2709	0.2709
POOL ESTIMATE	1.8160	0.0566	0.0405	0.0444	0.0465	0.0707	0.0857	0.1162
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	159.43	13.12	19.01	11.24	11.08	88.21	85.04	80.64
SAMPLE STD DEVIATION	3.5101	0.0580	0.0252	0.0368	0.0333	0.0540	0.1254	0.1591
CUMULATIVE TEST TIME	2.147	32.677	62.841	92.878	122.913	125.460	128.010	130.535
CUMULATIVE FAILURES	1.4200	2.6500	4.1200	5.6300	7.1400	8.5500	9.8700	11.1500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2709	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504
POOL ESTIMATE	0.1420	0.0533	0.0783	0.0692	0.0651	0.0609	0.0579	0.0550
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	76.34	86.68	56.52	38.39	30.16	21.75	15.73	10.08
SAMPLE STD DEVIATION	0.2162	0.0514	0.0361	0.0275	0.0237	0.0220	0.0199	0.0188
CUMULATIVE TEST TIME	133.023	163.148	193.266	223.606	253.301	283.464	313.431	343.632
CUMULATIVE FAILURES	12.7400	14.2100	15.5500	17.0100	18.4400	19.9500	21.4200	22.8200

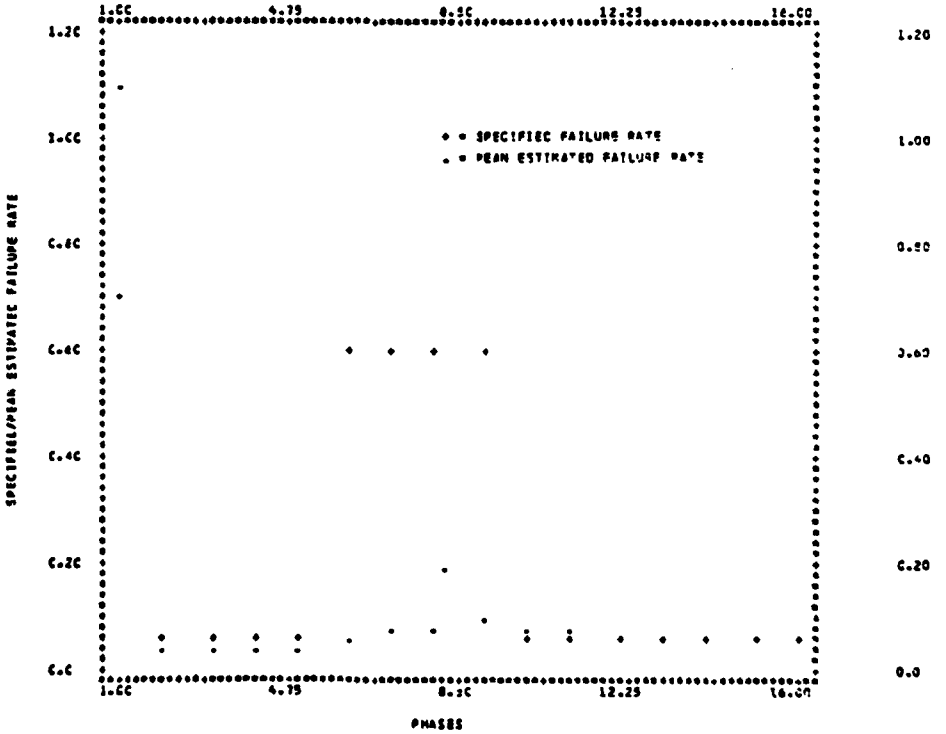


CASE 17

20 STEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2322	3.2504	3.2504	3.2504	3.2504	0.2709	0.2709	0.2709
MODEL ESTIMATE	1.0639	0.0495	0.0398	0.0378	0.0373	0.0333	0.0709	0.0496
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	56.27	0.98	20.45	24.12	25.47	91.12	88.19	89.23
SAMPLE STD DEVIATION	1.0963	0.0273	0.0214	0.0182	0.0144	0.0231	0.0304	0.0272
CUMULATIVE TEST TIME	4.301	64.276	124.450	184.981	245.142	250.164	255.160	260.155
CUMULATIVE FAILURES	2.9200	6.0200	8.8500	11.8100	14.7000	17.7500	20.7900	23.8700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2709	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.1058	0.0868	0.0755	0.0682	0.0637	0.0591	0.0571	0.0550
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	82.36	73.63	50.98	36.43	27.31	18.26	14.11	10.07
SAMPLE STD DEVIATION	0.0413	0.0298	0.0232	0.0194	0.0164	0.0146	0.0134	0.0123
CUMULATIVE TEST TIME	265.205	325.017	389.302	445.457	505.314	565.518	625.622	685.722
CUMULATIVE FAILURES	26.3500	29.4800	32.5000	35.4700	38.5600	41.2500	44.3800	47.3300

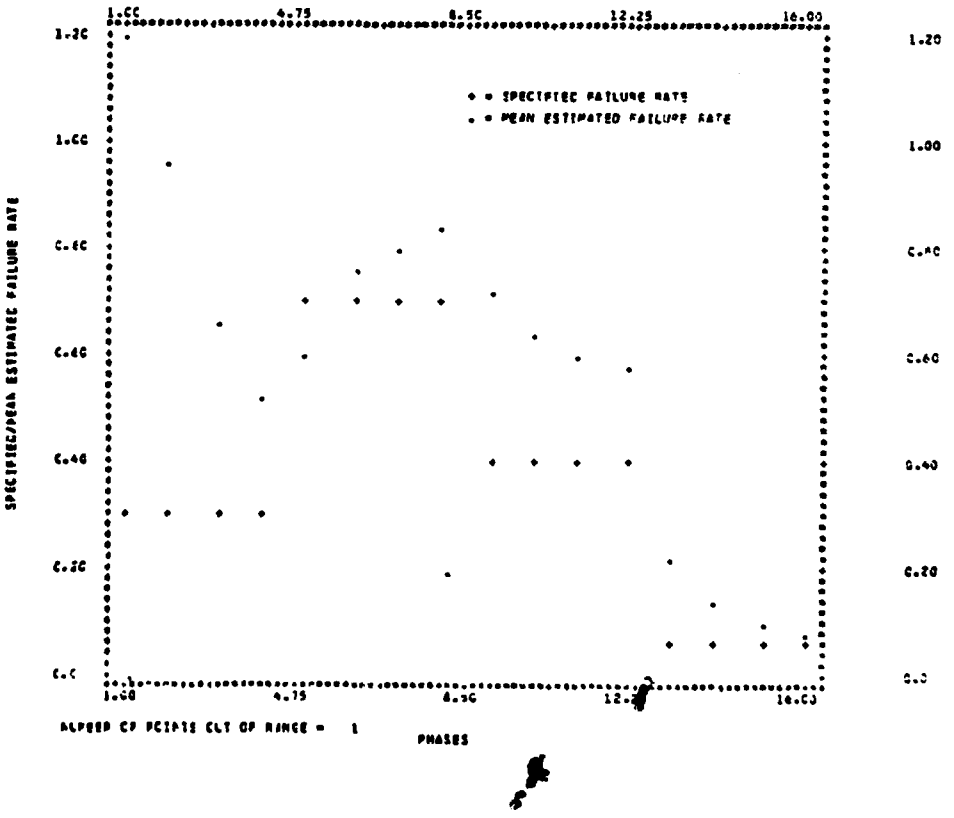


CASE 18

9 STEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.5417	0.5417	0.5417	0.5417	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	1.8200	0.9481	0.6453	0.5246	0.1058	0.1648	0.1508	0.1333
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	506.67	222.69	121.78	74.86	13.45	9.26	12.67	15.04
SAMPLE STD DEVIATION	4.7804	2.3516	0.7554	0.5059	0.0397	0.0660	0.0536	0.0403
CUMULATIVE TEST TIME	2.504	5.042	7.587	10.020	11.114	12.198	13.223	14.268
CUMULATIVE FAILURES	0.7100	1.4200	2.2600	2.9400	3.5000	4.4700	5.3700	6.1000

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.7238	0.6428	0.5941	0.5712	0.2266	0.1403	0.1027	0.0841
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	80.94	60.69	48.51	42.79	353.20	180.61	105.42	68.28
SAMPLE STD DEVIATION	0.5225	0.3726	0.3149	0.2982	0.0908	0.0485	0.0350	0.0230
CUMULATIVE TEST TIME	16.166	18.057	19.941	21.804	36.765	51.970	67.184	82.335
CUMULATIVE FAILURES	6.8200	7.5300	8.2700	9.0700	9.9200	10.6000	11.2000	11.9100

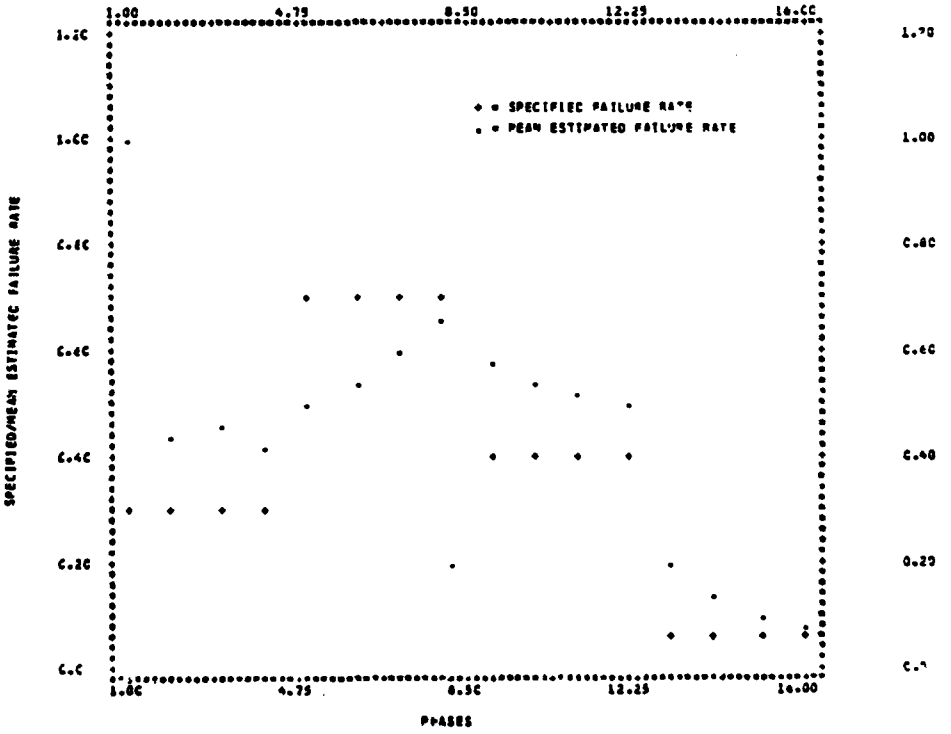


CASE 18

18 TESTS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.5417	0.5417	0.5417	0.5417	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	0.9924	0.4354	0.4509	0.4141	0.4922	0.5417	0.6050	0.6507
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	230.81	45.14	50.31	38.03	29.69	22.61	13.57	7.05
SAMPLE STD DEVIATION	1.8064	0.3275	0.3510	0.2213	0.2896	0.3006	0.3497	0.3093
CUMULATIVE TEST TIME	4.427	9.632	14.858	19.747	21.909	24.041	26.213	28.341
CUMULATIVE FAILURES	1.3600	3.0400	4.7600	6.5600	7.6700	9.3200	10.8400	12.4700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.5856	0.5325	0.5184	0.5015	0.2063	0.1326	0.1004	0.0829
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	46.41	33.12	29.61	25.38	312.54	165.13	100.70	65.73
SAMPLE STD DEVIATION	0.2372	0.1869	0.1658	0.1604	0.0580	0.0421	0.0282	0.0230
CUMULATIVE TEST TIME	32.125	35.650	39.705	43.459	73.610	103.736	133.755	163.686
CUMULATIVE FAILURES	13.8200	15.0400	16.5500	18.0700	19.4800	20.8400	22.3300	23.8200

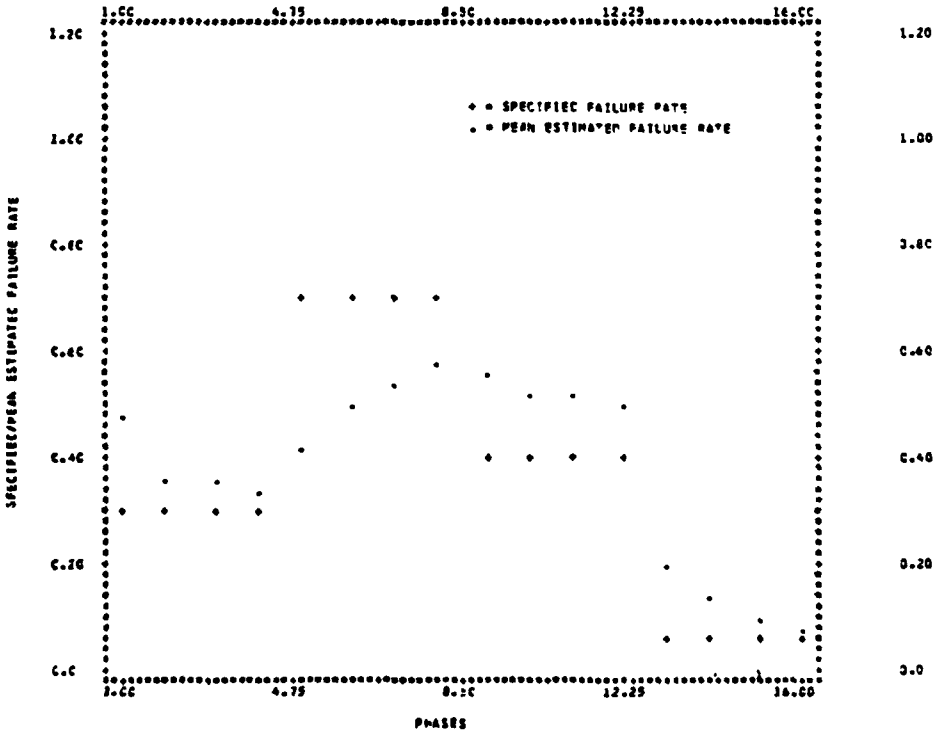


CASE 18

20 STEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.5417	0.5417	0.5417	0.5417	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	0.4793	0.3668	0.3657	0.3373	0.4107	0.4906	0.5454	0.5880
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	59.77	22.28	21.89	12.43	41.32	29.88	22.08	16.01
SAMPLE STD DEVIATION	0.4000	0.2244	0.1727	0.1377	0.1405	0.1791	0.1989	0.1904
CUMULATIVE TEST TIME	9.996	19.986	29.890	39.908	44.206	48.475	52.744	57.039
CUMULATIVE FAILURES	3.0300	5.6000	9.1800	12.0600	14.4400	18.1200	21.0300	23.9500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.5520	0.5296	0.5202	0.5038	0.2070	0.1310	0.1005	0.0825
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	38.01	32.40	30.04	25.95	314.05	161.90	100.99	65.05
SAMPLE STD DEVIATION	0.1544	0.1516	0.1315	0.1207	0.0419	0.0237	0.0184	0.0139
CUMULATIVE TEST TIME	64.565	72.651	79.547	87.097	167.563	208.236	267.736	327.823
CUMULATIVE FAILURES	26.9100	29.8600	33.1100	36.0300	38.8700	41.5400	44.8200	47.5000



APPENDIX B

Results of Test 2

This appendix contains the results for Cases 1, 3, 7, and 18. The planned test times were generated for a probability of survival of .99.

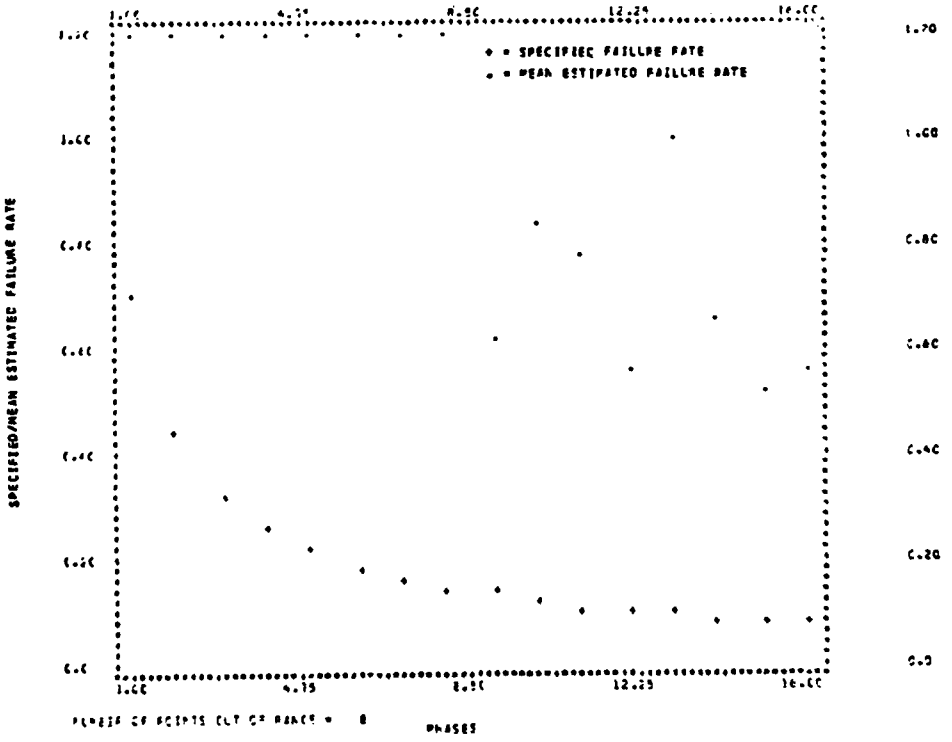
A detailed description of the format of the results can be found in Appendix A.

CASE 1

5 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	C.7CCC	0.4240	G.3200	C.2550	C.2130	C.1830	C.1610	0.1440
PLANNED TEST TIME	C.0143	C.0332	0.0314	C.0394	C.0472	0.0549	0.0624	C.0698
MODEL ESTIMATE	31.8283	16.3034	9.3556	5.7270	3.6902	2.4186	1.2357	1.3603
ESTIMATE TERMS OF DISCREPANCY OF ACTUAL FAILURE RATE	4433.54	3656.53	1586.12	1361.97	1613.71	1221.66	667.59	844.63
SAMPLE STD DEVIATION	26.7765	18.6836	5.3205	3.6890	5.9768	4.3512	1.2041	1.9657
CUMULATIVE TEST TIME	0.071	0.187	0.343	C.535	C.774	1.045	1.355	1.707
CUMULATIVE FAILURES	C.03CC	0.06C0	C.09CC	C.1300	C.18CC	C.23CC	C.29CC	C.28CC

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	C.1330	0.1180	0.1050	C.1010	C.0936	0.0876	0.0823	C.0776
PLANNED TEST TIME	C.0756	0.0852	C.0922	C.0995	C.1074	C.1147	0.1221	0.1295
MODEL ESTIMATE	C.6263	0.8411	0.7862	C.5501	C.6903	0.6564	0.5116	0.5547
ESTIMATE TERMS OF DISCREPANCY OF ACTUAL FAILURE RATE	373.15	612.81	624.28	444.63	551.56	649.32	521.62	614.EC
SAMPLE STD DEVIATION	C.5297	1.0848	1.2175	C.7225	2.5628	1.4884	1.3351	C.5917
CUMULATIVE TEST TIME	2.CEE	2.513	2.965	3.466	4.CC1	4.572	5.182	5.826
CUMULATIVE FAILURES	C.2SC0	0.3303	0.36CC	C.3800	0.42CC	C.47CC	C.48CC	C.52CC

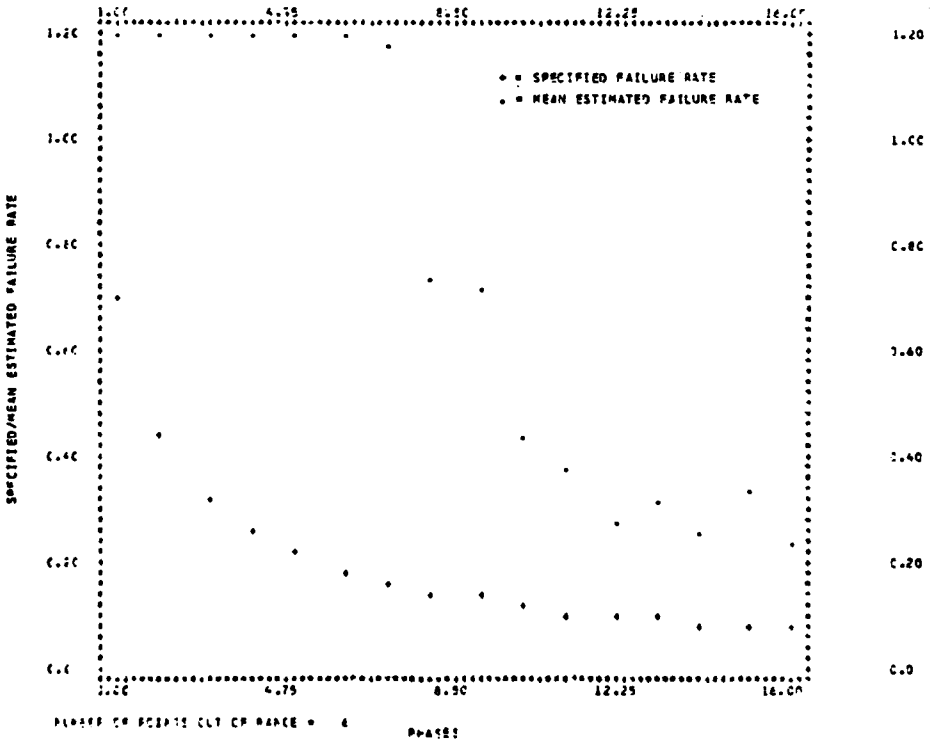


CASE 1

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	C.7C2C	0.4340	0.3201	C.2550	C.213C	0.1C3C	C.161C	0.144C
STOPPED TEST TIME	0.0143	C.C232	0.0314	C.C364	C.C432	0.0544	0.0624	C.C65E
MODEL ESTIMATE	16.3316	3.6C3C	2.7172	1.4535	1.3889	1.3854	1.1818	0.7745
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	2226.45	780.64	749.14	470.19	552.C6	653.C6	624.C3	41C.C7
SAMPLE STD DEVIATION	17.4622	3.8113	3.3159	1.7987	2.3238	2.5653	2.5258	1.4261
CUMULATIVE TEST TIME	0.142	0.373	0.685	1.078	1.548	2.C54	2.716	3.411
CUMULATIVE FAILURES	C.11CC	0.21CC	0.3200	C.3700	C.47CC	C.6CCC	C.68CC	C.77CC

PHASE	9	1C	11	12	13	14	15	16
ACTUAL FAILURE RATE	C.133C	0.1180	C.1050	C.1010	C.C936	0.C876	0.C823	0.C77E
STOPPED TEST TIME	C.C756	0.C859	0.0922	C.C995	C.1C74	C.1147	C.1221	C.1295
MODEL ESTIMATE	C.7105	0.4429	0.3654	C.2846	C.3154	C.2536	C.3424	0.2326
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	434.22	275.37	253.99	181.83	241.22	189.54	315.99	199.77
SAMPLE STD DEVIATION	1.2661	0.4564	C.6555	C.2998	C.5723	C.2335	C.8563	C.2852
CUMULATIVE TEST TIME	4.16C	5.CC7	5.926	6.915	7.978	9.119	1C.332	11.62C
CUMULATIVE FAILURES	0.94CC	1.C3CC	1.12CC	1.2200	1.28CC	1.51CC	1.63CC	1.75CC

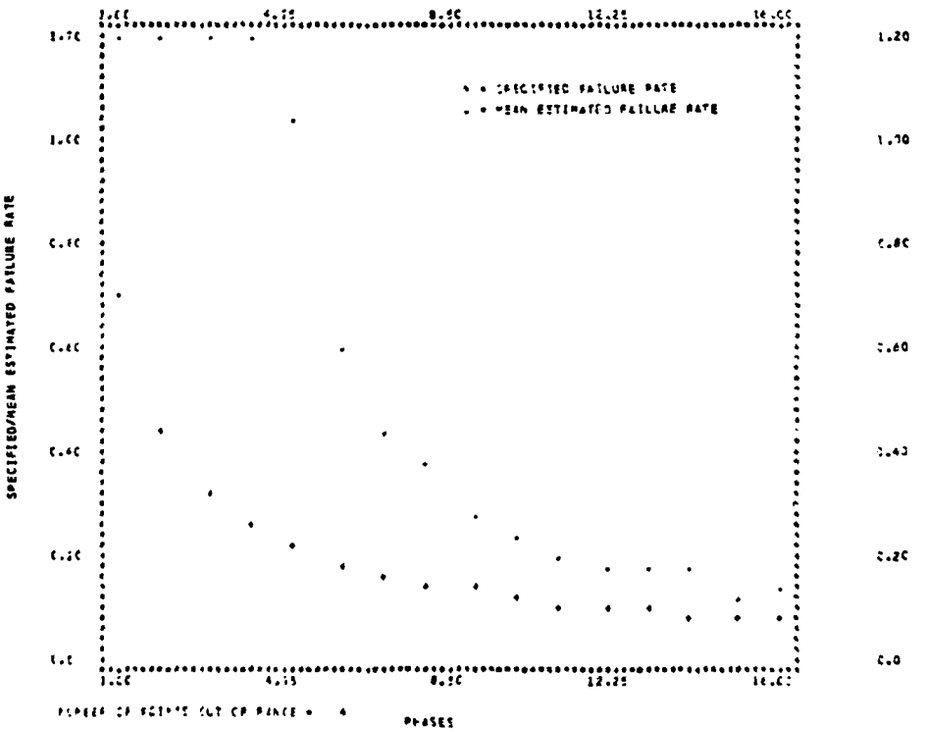


CASE 1

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7020	0.4340	0.3200	0.2550	0.2130	0.1830	0.1610	0.1440
PLANNED TEST TIME	0.0143	0.0232	0.0314	0.0394	0.0472	0.0546	0.0624	0.0698
MODEL ESTIMATE	7.3817	4.5436	1.9522	1.0595	1.0386	0.6045	0.4370	0.3708
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	951.52	1035.09	510.06	1055.82	361.66	220.35	171.47	157.76
SAMPLE STD DEVIATION	11.2572	9.8559	2.8569	10.5748	2.5168	0.1529	0.4225	0.7662
CUMULATIVE TEST TIME	0.285	0.744	1.368	2.149	3.087	4.376	5.417	6.808
CUMULATIVE FAILURES	0.2500	0.4100	0.7300	1.0900	1.3200	1.5500	1.8900	1.9500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.1330	0.1180	0.1090	0.1010	0.0936	0.0876	0.0823	0.0776
PLANNED TEST TIME	0.0756	0.0832	0.0922	0.0995	0.1074	0.1147	0.1221	0.1295
MODEL ESTIMATE	0.2642	0.2334	0.2036	0.1782	0.1707	0.1773	0.1241	0.1319
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	113.71	97.61	87.07	76.48	82.36	102.35	90.75	69.44
SAMPLE STD DEVIATION	0.4394	0.2417	0.2388	0.2140	0.2420	0.4362	0.0571	0.1771
CUMULATIVE TEST TIME	8.312	10.006	11.844	13.824	15.960	18.246	20.635	23.255
CUMULATIVE FAILURES	2.1600	2.4300	2.5800	2.7700	3.0100	3.1800	3.3500	3.6200

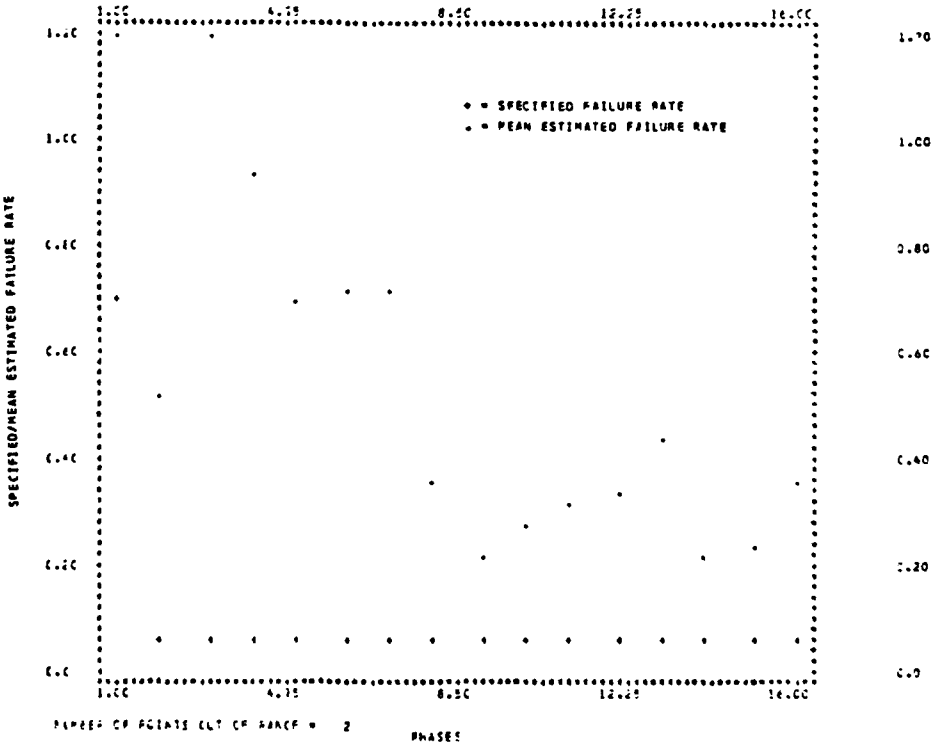


CASE 3

5 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2010	0.2010	0.2010	0.2010	0.2010	0.2010	0.2010	0.2010
MODEL ESTIMATE	32.0656	0.5135	1.9666	0.9339	0.7085	0.7112	0.7705	0.3552
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	4463.65	927.70	3833.15	1767.81	1317.82	1322.65	1441.74	610.50
SAMPLE STD DEVIATION	27.0078	0.3128	4.9185	1.4566	1.0875	1.0373	1.1814	0.3305
CUMULATIVE TEST TIME	0.072	1.075	2.070	3.067	4.068	5.062	6.061	7.062
CUMULATIVE FAILURES	0.0500	0.0500	0.1000	0.2300	0.2700	0.3600	0.4300	0.4600

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.2010	0.2010	0.2010	0.2010	0.2010	0.2010	0.2010	0.2010
MODEL ESTIMATE	0.2201	0.2776	0.3250	0.3424	0.4301	0.2221	0.2413	0.3036
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	340.23	455.10	549.99	584.87	760.16	344.18	382.57	507.22
SAMPLE STD DEVIATION	0.1745	0.4533	0.8021	0.4751	0.8258	0.2087	0.3825	0.7664
CUMULATIVE TEST TIME	8.063	9.068	10.070	11.065	12.068	13.065	14.067	15.070
CUMULATIVE FAILURES	0.4700	0.5100	0.5600	0.6400	0.7100	0.7500	0.7900	0.8300



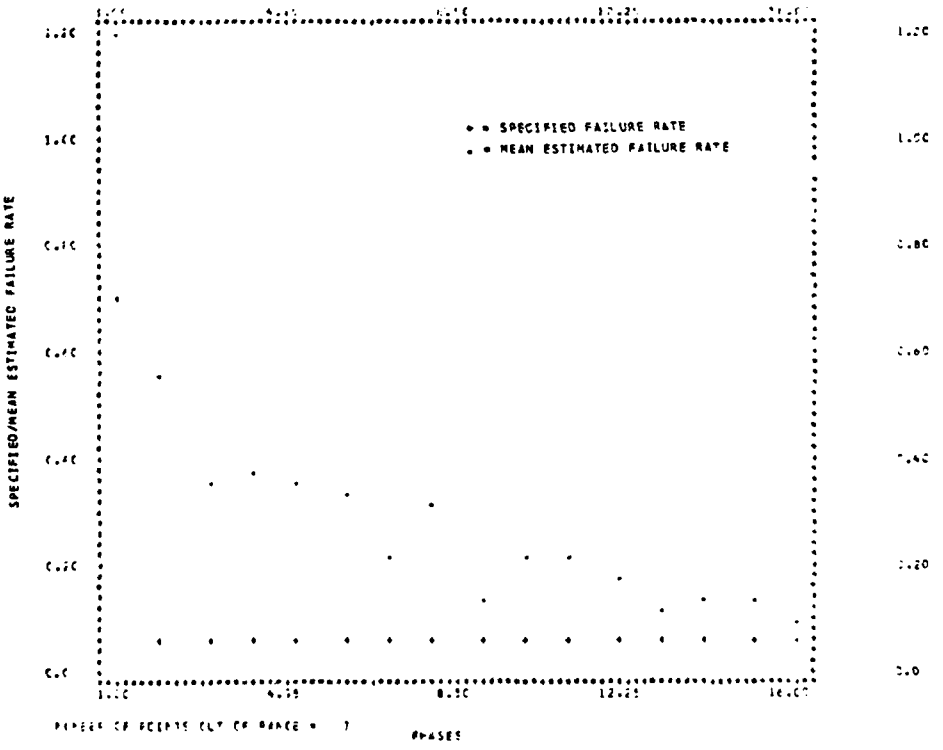
NUMBER OF POINTS OUT OF RANGE = 2

CASE 3

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7CCC	0.C5CC	0.0500	C.0500	C.C5CC	C.C5CC	C.C5CC	C.C5CC
PLANNED TEST TIME	0.0144	0.2C1C	C.2C1C	C.2010	C.2C1C	C.2C1C	C.2C1C	C.2C1C
ACCEL ESTIMATE	21.3252	0.5628	0.3642	C.3768	C.3535	0.3435	C.2254	0.2177
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	2947.03	1025.50	628.43	653.64	606.92	586.95	350.88	334.42
SAMPLE STD DEVIATION	19.1402	1.0362	0.5002	C.5325	C.5064	0.4C52	C.271C	C.2C74
CUMULATIVE TEST TIME	0.142	2.142	4.140	6.135	8.134	1C.126	12.128	14.128
CUMULATIVE FAILURES	C.13CC	0.2203	C.3400	C.4600	C.6100	0.7600	C.8600	C.9700

PHASE	9	1C	11	12	13	14	15	16
ACTUAL FAILURE RATE	C.05CC	C.C5CC	C.0500	C.05CC	C.C5CC	0.C5CC	0.05CC	C.C5CC
PLANNED TEST TIME	C.2C1C	0.2C1C	C.2C1C	C.2C1C	C.2C1C	C.2C1C	C.7C1C	C.2C1C
ACCEL ESTIMATE	C.1456	0.2130	0.2102	C.1847	C.1244	C.1321	C.14CC	C.0994
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	191.58	325.64	320.48	269.46	148.86	164.19	176.99	98.72
SAMPLE STD DEVIATION	C.1736	0.9C55	0.4478	C.5876	C.1471	0.2141	C.2916	0.0595
CUMULATIVE TEST TIME	16.135	18.132	2C.13C	22.131	24.125	26.126	28.126	30.127
CUMULATIVE FAILURES	1.01CC	1.05C0	1.2200	1.3000	1.44CC	1.57CC	1.68C0	1.76CC



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AN ACCURACY ANALYSIS OF THE ARMY MATERIEL SYSTEM ANALYSIS ACTIV--ETC(U)
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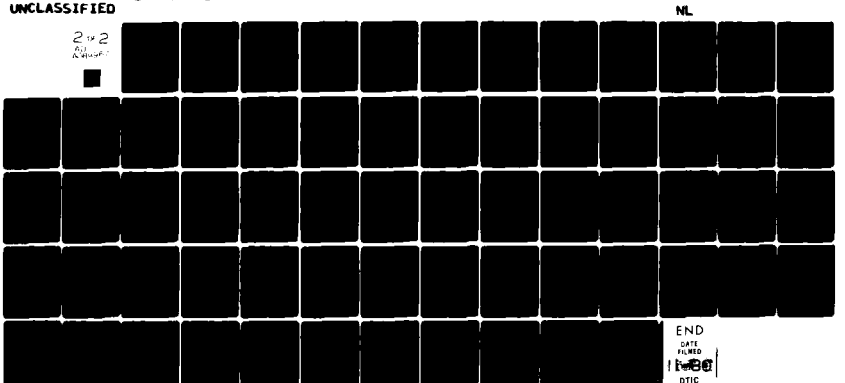

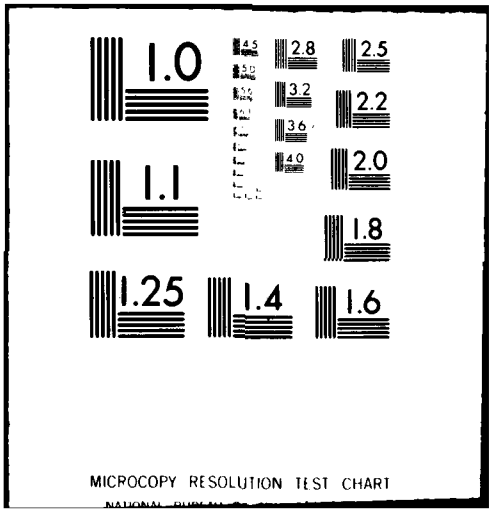
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2.5
3.2
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1.8
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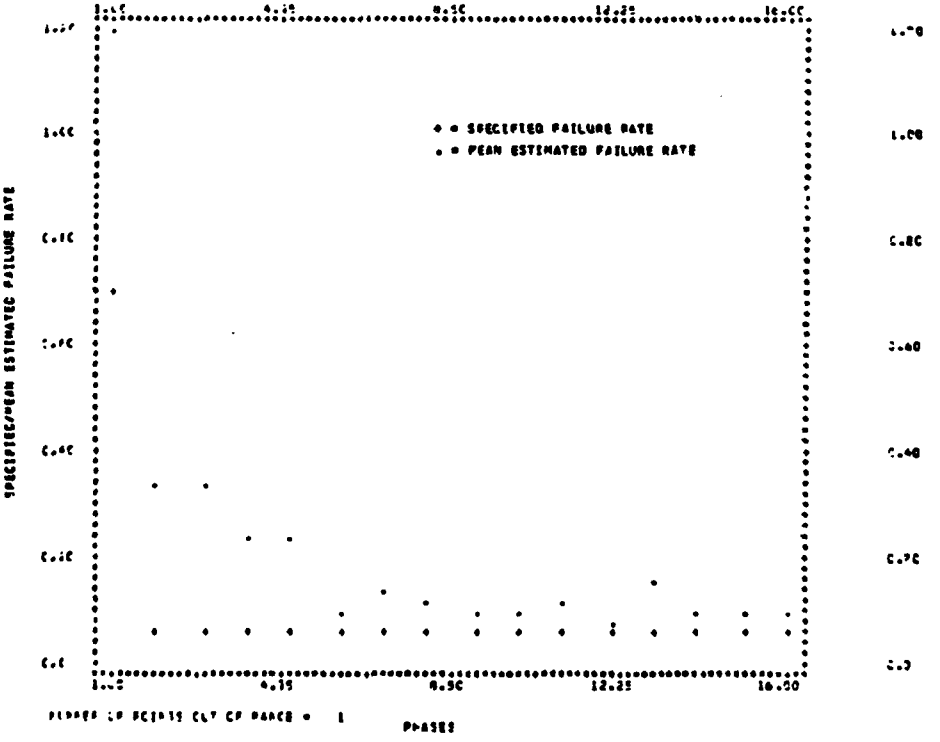
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART

CASE 3

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	C.2CCC	0.05CC	0.0500	C.05CC	C.05CC	C.05CC	C.05CC	C.05CC
PLANNED TEST TIME	0.0144	3.2C1C	C.2C1C	C.2010	C.2C1C	C.2C1C	C.2C1C	C.2C1C
MODEL ESTIMATE	5.4678	0.3441	0.3305	C.2375	C.2337	0.1C56	C.1454	C.1124
ESTIMATE EXPRESSED AS PERCENTAGE OF ACTUAL FAILURE RATE	1252.51	588.17	560.95	374.97	367.46	111.45	190.8C	124.82
SAMPLE STD DEVIATION	1C.C711	0.3765	C.51C7	C.3180	C.7C25	0.1281	0.2652	0.1771
CUMULATIVE TEST TIME	0.288	4.304	8.288	12.280	16.289	20.252	24.288	28.292
CUMULATIVE FAILURES	C.17CC	0.41CC	C.61CC	C.85CC	C.44CC	1.1CCC	1.28CC	1.45CC

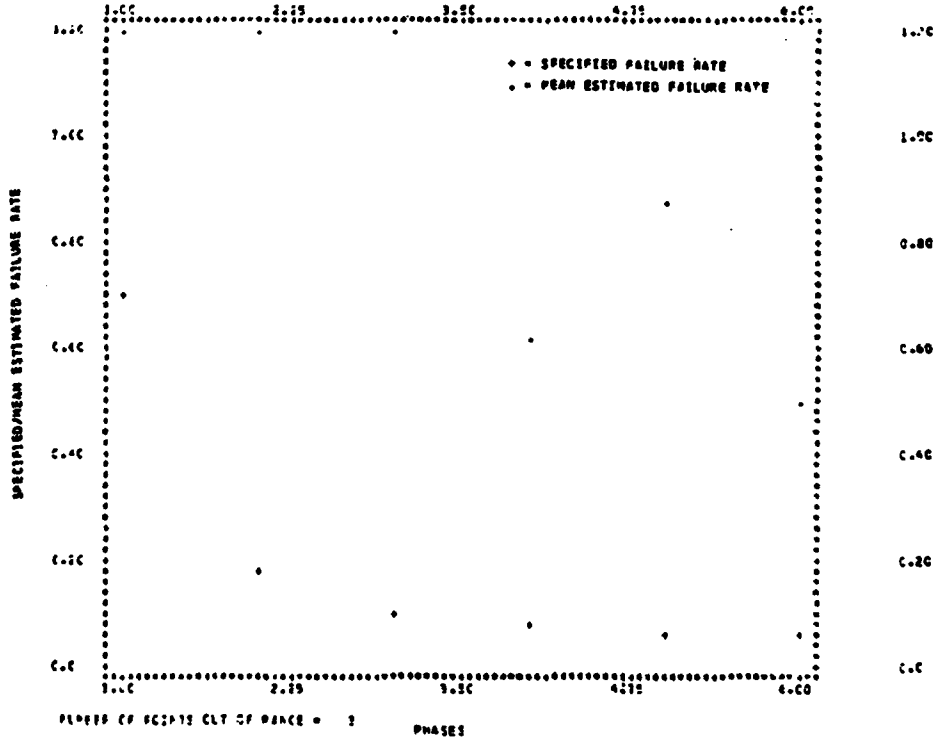
PHASE	9	1C	11	12	13	14	15	16
ACTUAL FAILURE RATE	C.05CC	0.05CC	0.0500	C.0500	C.05CC	C.05CC	C.05CC	C.05CC
PLANNED TEST TIME	C.2C1C	3.2C1C	C.2C1C	C.2010	C.2C1C	C.2C1C	C.2C1C	C.2C1C
MODEL ESTIMATE	C.0545	C.0551	0.1205	C.C884	C.1682	0.0548	0.1C4E	C.C556
ESTIMATE EXPRESSED AS PERCENTAGE OF ACTUAL FAILURE RATE	89.3E	9C.24	141.C1	77.27	236.47	85.91	1C5.4C	99.29
SAMPLE STD DEVIATION	C.115C	0.12C9	C.1555	C.0974	C.5484	0.1225	C.27EE	C.2C6E
CUMULATIVE TEST TIME	32.256	36.256	40.288	44.252	48.278	52.288	56.250	6C.28?
CUMULATIVE FAILURES	1.6CCC	1.8CC9	2.11C8	2.2400	2.4CCC	2.77CC	2.9CCC	3.1*0C



CASE 7

$ ITEMS

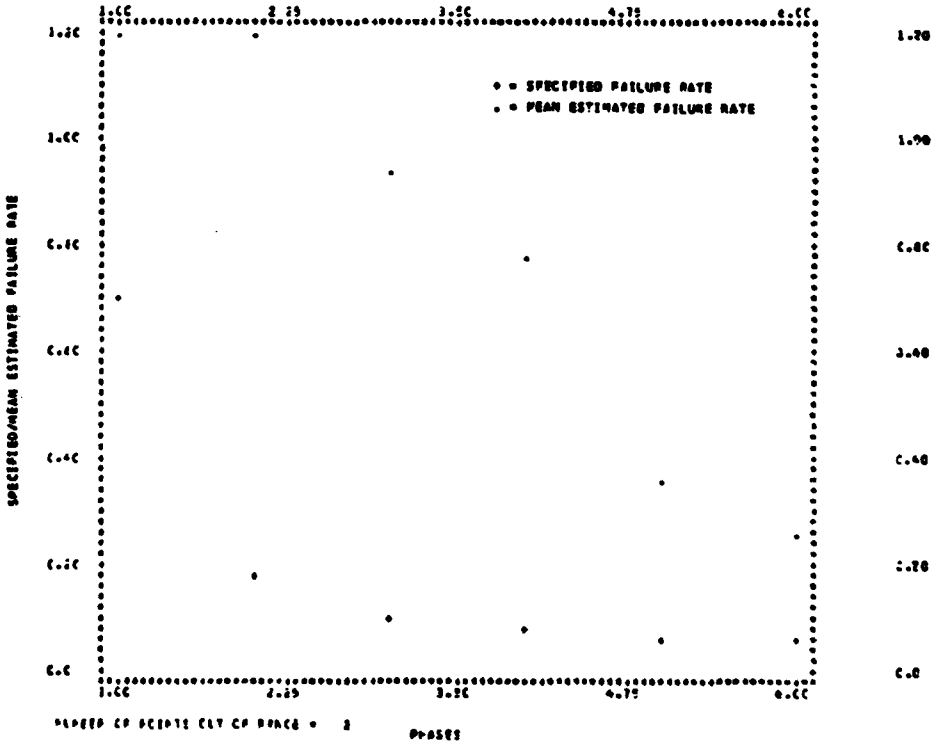
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.1000	0.1000	0.0700	0.0000	0.0000
PLANNED TEST TIME	0.0100	0.0250	0.0500	0.1000	0.1000	0.2000
MODEL ESTIMATE	15.8422	4.7837	1.3617	0.6279	0.8815	0.5009
ESTIMATE BASED ON 95 PERCENT CF ACTUAL FAILURE RATE	2734.55	2551.63	1144.58	735.66	1269.16	901.74
SAMPLE STD DEVIATION	10.4211	6.5765	1.5446	0.4792	0.5556	0.4431
CUMULATIVE TEST TIME	0.072	0.250	0.622	1.482	2.314	3.318
CUMULATIVE FAILURES	0.0200	0.0500	0.0700	0.1000	0.1000	0.2000



CASE 7

10 ITEMS

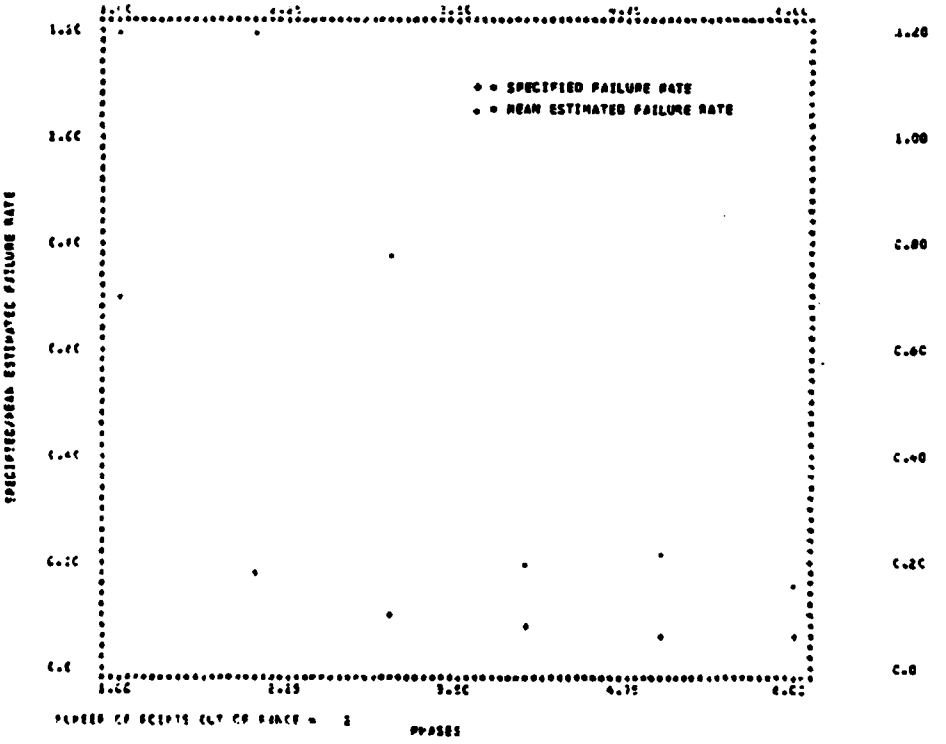
PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.2000	0.1000	0.1000	0.0700	0.0400	0.0500
PHASE TEST TIME	0.0104	0.0558	0.0648	0.1322	0.1675	0.2010
MODEL ESTIMATE	0.0664	1.5283	0.9321	0.7858	0.3577	0.2596
ESTIMATE BASED AT PERCENTAGE OF ACTUAL FAILURE RATE	766.63	749.04	779.30	933.91	456.22	419.28
SAMPLE SIZE CONSTANT	2.0424	1.6045	1.0682	1.3208	0.5474	0.4262
CUMULATIVE TEST TIME	0.141	0.455	1.642	2.959	4.626	6.625
CUMULATIVE FAILURES	0.010	0.110	0.310	0.380	0.440	0.500



CASE 1

20 TYPE1

PHASE	1	2	3	4	5	6
ACTUAL FAILURE RATE	0.7000	0.1800	0.1000	0.0700	0.0400	0.0200
AVERAGE TEST TIME	0.0144	0.0558	0.0948	0.1322	0.1679	0.2010
MODEL ESTIMATE	12.0566	1.2754	0.7000	0.2066	0.2281	0.1574
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	1622.62	610.75	635.87	731.90	366.96	314.89
SAMPLE STD DEVIATION	17.3610	3.0869	1.6882	0.1780	0.1673	0.7551
CUMULATIVE TEST TIME	0.284	1.369	3.262	5.918	9.256	13.257
CUMULATIVE FAILURES	0.1700	0.3200	0.5700	0.7200	0.8500	1.0100

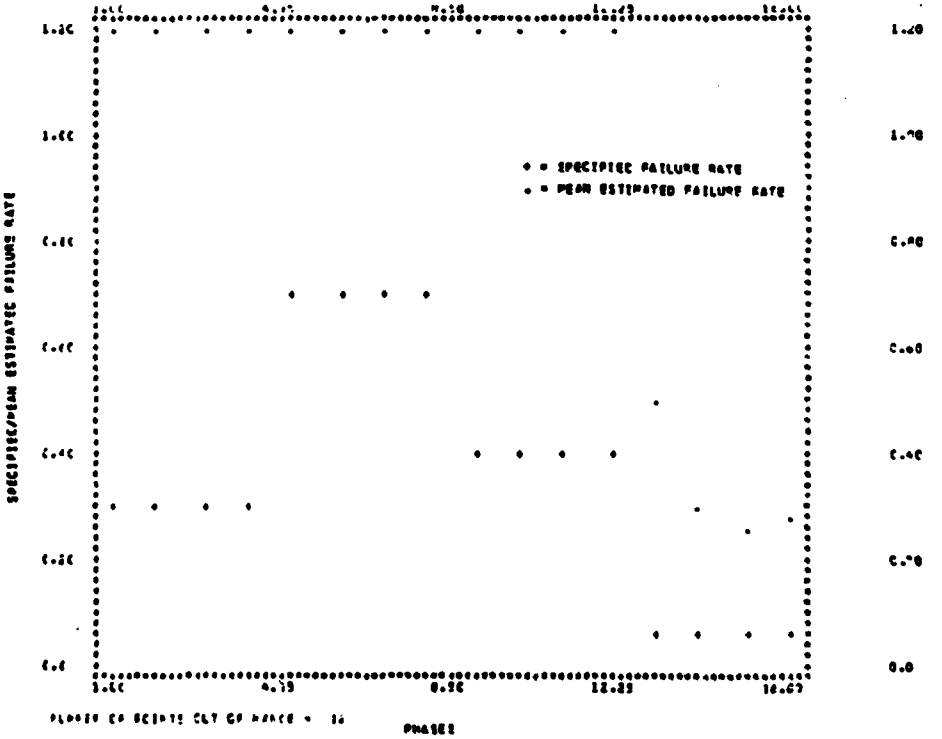


CASE 18

9 STEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.7000	0.1000	0.7000	0.7000
PLANNED TEST TIME	0.0139	0.0139	0.0139	0.0139	0.0144	0.0144	0.0144	0.0144
MODEL ESTIMATE	15.2334	6.9019	10.1656	4.9044	6.9225	5.4432	3.7474	4.8147
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	4577.81	2201.17	3288.53	1361.59	821.78	685.32	435.34	581.81
SAMPLE STD DEVIATION	12.0322	8.5345	10.3442	6.4909	14.3165	12.5801	4.3179	8.4782
CUMULATIVE TEST TIME	0.146	0.233	0.499	0.666	0.737	0.809	0.881	0.952
CUMULATIVE FAILURES	0.04CC	0.06CC	0.2000	0.2500	0.2700	0.2900	0.3300	0.4100

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.0900	0.0900	0.0900	0.0900
PLANNED TEST TIME	0.0251	0.0251	0.0251	0.0251	0.2010	0.2010	0.2010	0.2010
MODEL ESTIMATE	4.5556	3.1553	3.3009	4.1636	0.9057	0.2562	0.2036	0.2716
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	1038.90	688.83	725.22	940.91	911.36	484.82	426.78	443.28
SAMPLE STD DEVIATION	8.4262	6.2560	4.6361	8.9508	0.3009	0.2215	0.3966	0.6621
CUMULATIVE TEST TIME	1.077	1.202	1.327	1.452	2.459	3.466	4.656	5.656
CUMULATIVE FAILURES	0.4600	0.4500	0.5500	0.6300	0.6400	0.6500	0.7200	0.7900

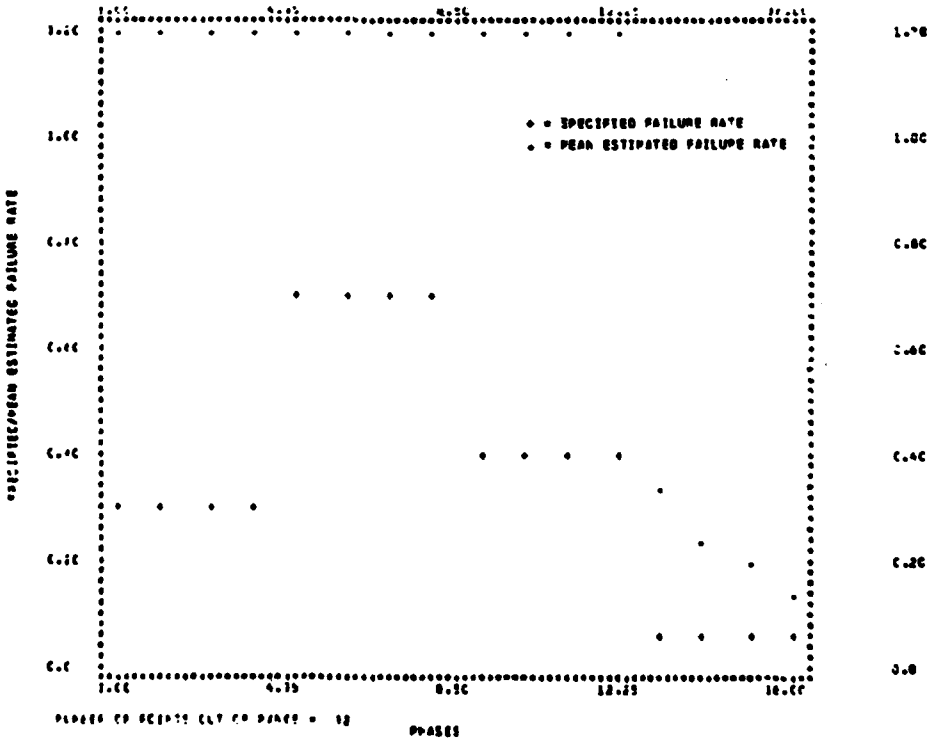


CASE 18

18 STEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.7000	0.1000	0.7000	0.7000
PLANNED TEST TIME	0.0333	0.0333	0.0333	0.0333	0.0144	0.0144	0.0144	0.0144
ACCEL ESTIMATE	7.6198	6.3199	4.7355	3.2234	1.4147	2.8902	2.7736	2.4656
ESTIMATE BASED AS DEVIATION OF ACTUAL FAILURE RATE	2439.43	2036.43	1478.51	641.14	459.98	367.18	287.70	252.14
SAMPLE STD DEVIATION	9.4419	9.0590	7.3556	3.0223	6.4445	3.2814	5.0178	2.7750
CUMULATIVE TEST TIME	0.333	0.666	0.999	1.331	1.474	1.617	1.760	1.903
CUMULATIVE FAILURES	0.1000	0.2000	0.3000	0.5300	0.6600	0.7700	0.8100	0.9200

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.0251	0.0251	0.0251	0.0251	0.2010	0.2010	0.2010	0.2010
ACCEL ESTIMATE	2.4416	2.3681	2.2541	1.5479	0.3427	0.2412	0.2056	0.1985
ESTIMATE BASED AS DEVIATION OF ACTUAL FAILURE RATE	510.39	497.02	463.92	286.95	585.30	384.35	336.88	176.64
SAMPLE STD DEVIATION	5.5008	5.2101	5.0800	2.5015	0.7008	0.2230	0.2695	0.1447
CUMULATIVE TEST TIME	2.193	2.462	2.657	2.907	4.908	6.918	8.929	10.939
CUMULATIVE FAILURES	1.0200	1.1200	1.2400	1.3300	1.3500	1.3600	1.4500	1.4700

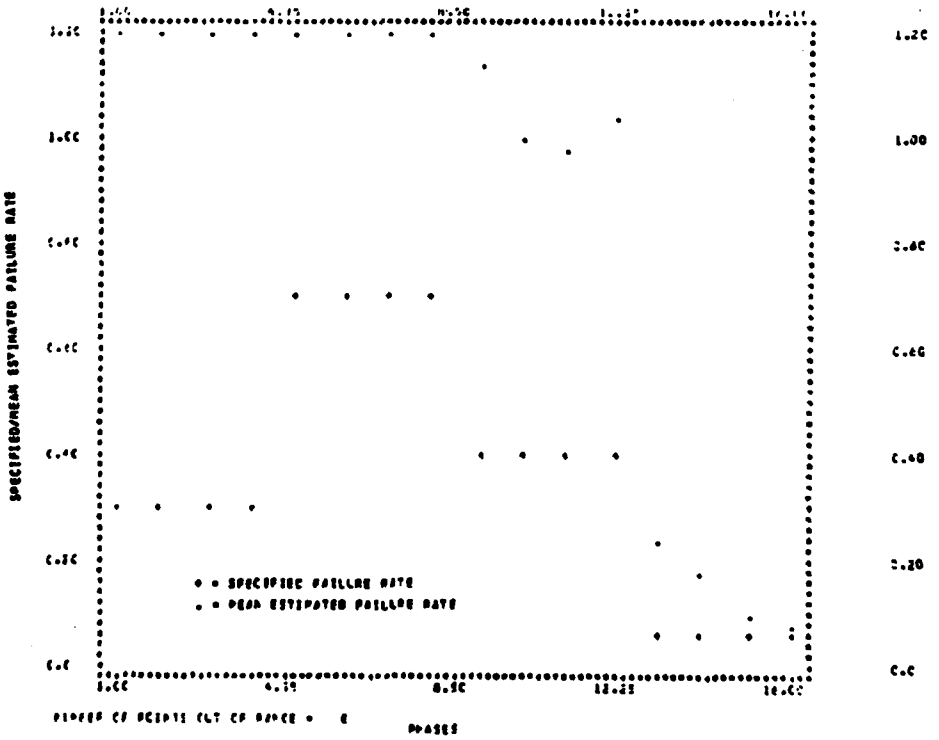


CASE 18

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	C.3CCC	0.3CCC	C.3CCC	C.3000	C.1000	0.1CCC	C.1CCC	C.1CCC
PLANNED TEST TIME	C.0335	0.0335	0.0335	C.0335	C.C144	0.C144	C.C144	C.C144
MODEL ESTIMATE	3.5621	1.5C51	1.0587	1.3944	2.1276	2.7251	1.5564	1.7C45
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	1C67.1C	535.C2	519.55	364.06	261.05	285.3C	128.C6	142.51
SAMPLE STD DEVIATION	6.7221	2.1145	2.3548	1.8112	3.3395	7.5C45	2.0274	2.4CC3
CUMULATIVE TEST TIME	C.666	1.334	2.CCC	2.666	3.332	3.237	3.523	3.809
CUMULATIVE FAILURES	0.15CC	0.35CC	C.61CC	C.82CC	1.C2CC	1.25C0	1.44CC	1.62CC

PHASE	9	1C	11	12	13	14	15	16
ACTUAL FAILURE RATE	C.4CCC	3.4CCC	0.4CCC	C.4CCC	C.C5CC	C.C5CC	C.C5CC	C.C5CC
PLANNED TEST TIME	C.C251	0.C251	0.0251	C.C251	C.2C1C	0.2C10	C.2C1C	C.2C1C
MODEL ESTIMATE	1.1466	C.5557	C.9717	1.0478	C.234C	0.1723	0.1C66	0.C635
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	186.66	146.42	142.84	161.55	368.01	244.59	117.19	67.56
SAMPLE STD DEVIATION	1.3C00	0.63C4	1.2512	2.2705	C.14C9	C.2556	C.C77C	C.C511
CUMULATIVE TEST TIME	4.3C5	4.8C5	5.3C9	5.809	5.816	13.612	17.C15	21.619
CUMULATIVE FAILURES	1.8CCC	2.C4CC	2.26CC	2.4000	2.53CC	2.77CC	2.84CC	2.96CC



APPENDIX C

Results of Test MOD1

1. Test MOD1

Test MOD1 used the AMSAA model to estimate the failure rate of the items tested except as described below. A more detailed discussion of the modification can be found in Section V-D.

Use of the AMSAA model was modified as follows:

a. The point estimate of the failure rate,

$$r_p = \frac{\text{number of failures during a phase}}{\text{total test time during a phase}} ,$$

was used whenever cumulative test time over all items was less than 10 hours.

b. The slope of the reliability growth pattern was estimated using the current point estimator, r_p, and the previous estimate, $\hat{r}_{i-1}$, of the failure rate as follows:

$$\text{SLOPE} = r_p - \hat{r}_{i-1} .$$

Increasing slope was then determined from the following relationship:

$$r_p - \hat{r}_{i-1} \geq .07 .$$

If the slope was increasing, the point estimate, r_p, was used as the current estimate of the failure rate. Then, the AMSAA model was reinitialized, that is, time and failures prior to an increasing slope were not considered in future estimates made by the model.

2. The Results

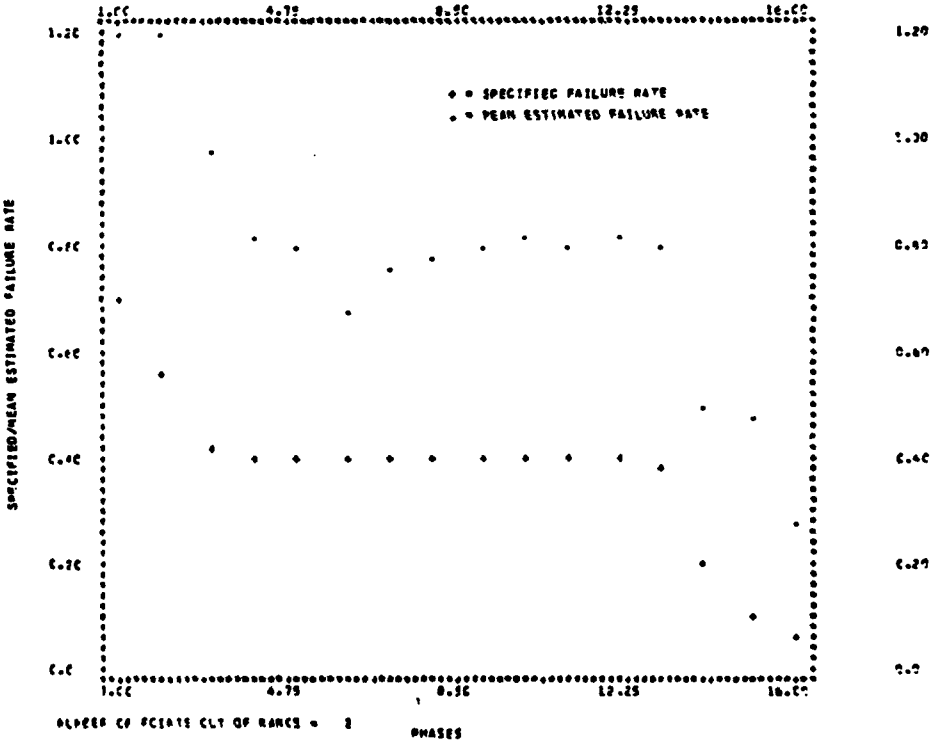
Results for Cases 4, 6, 15, and 18 are presented here as representative of the effect the modifications had on the performance of the model. A detailed description of the format of the results can be found in Appendix A.

CASE 4

5 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.5500	0.4250	0.4050	0.4000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2222	0.2555	0.3824	0.4013	0.4063	0.4063	0.4063	0.4063
MODEL ESTIMATE	1.3450	1.2900	0.9888	0.8159	0.8067	0.6744	0.7687	0.7757
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	92.15	134.54	132.65	101.47	101.68	68.64	92.17	93.93
SAMPLE STD DEVIATION	0.6735	0.7356	0.6517	0.4587	0.4655	0.5281	0.4922	0.5609
CUMULATIVE TEST TIME	1.674	2.418	4.202	6.046	7.942	9.842	11.657	13.580
CUMULATIVE FAILURES	0.6400	1.9100	2.0700	2.8900	3.2500	4.1700	4.9900	5.6500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.3750	0.2000	0.1000	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	0.4334	0.8126	1.6252	3.2504
MODEL ESTIMATE	0.8014	0.8147	0.7922	0.8142	0.7981	0.4575	0.4816	0.2490
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	100.41	103.67	98.05	103.55	112.82	146.76	380.57	485.52
SAMPLE STD DEVIATION	0.5065	0.4576	0.4462	0.7469	0.7561	0.4259	1.5370	1.0418
CUMULATIVE TEST TIME	15.442	17.215	19.186	21.049	23.075	26.860	34.326	45.304
CUMULATIVE FAILURES	6.4400	7.1500	7.7800	8.2700	9.0800	10.0800	10.5400	11.6400

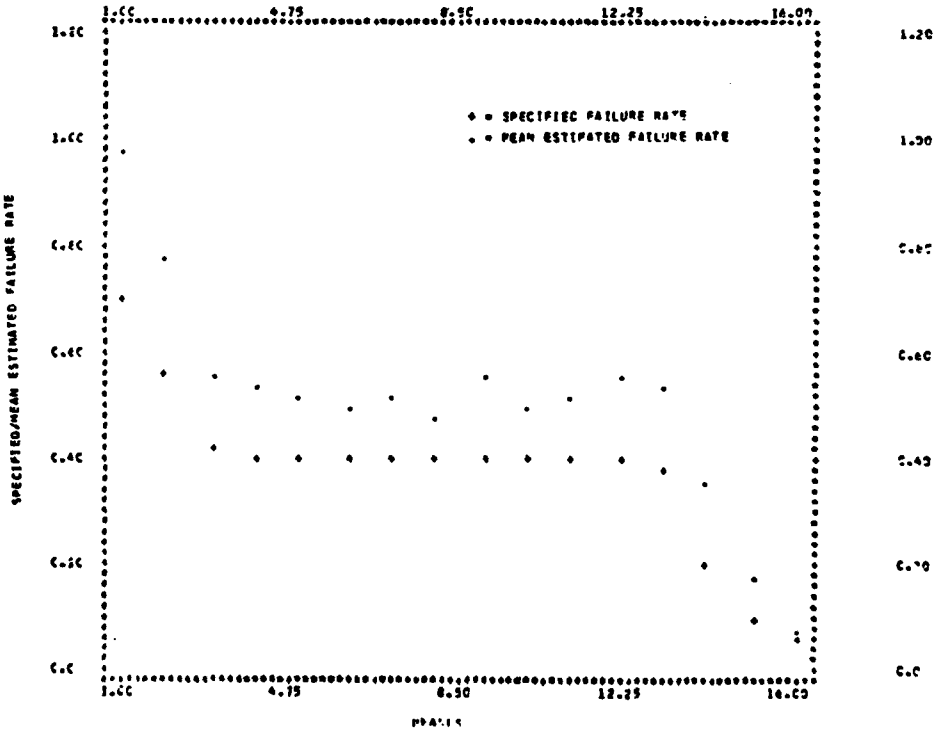


CASE 4

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.5500	0.4250	0.4050	0.4000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2955	0.3824	0.4013	0.4063	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.9736	0.7761	0.5674	0.5329	0.5258	0.5026	0.5283	0.4779
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	39.13	41.11	33.50	31.58	31.45	25.65	32.08	19.48
SAMPLE STD DEVIATION	0.6085	0.5434	0.3315	0.3378	0.2656	0.3714	0.2459	0.2967
CUMULATIVE TEST TIME	2.136	4.687	8.462	12.133	15.883	19.633	23.410	27.196
CUMULATIVE FAILURES	1.5400	2.9400	4.1400	5.8000	7.1600	8.4600	10.2000	11.6400

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.3750	0.2000	0.1000	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	0.4334	0.8126	1.6252	3.2504
MODEL ESTIMATE	0.5674	0.4626	0.5256	0.5553	0.5457	0.3559	0.1863	0.0858
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	41.84	29.15	31.40	38.83	45.53	77.94	86.25	71.59
SAMPLE STD DEVIATION	0.3480	0.3131	0.3157	0.2990	0.3676	0.2904	0.1443	0.0556
CUMULATIVE TEST TIME	30.943	34.723	38.459	42.187	46.178	53.627	68.585	98.301
CUMULATIVE FAILURES	12.9700	14.4500	16.0100	17.2200	18.6900	20.5800	22.1500	23.9300

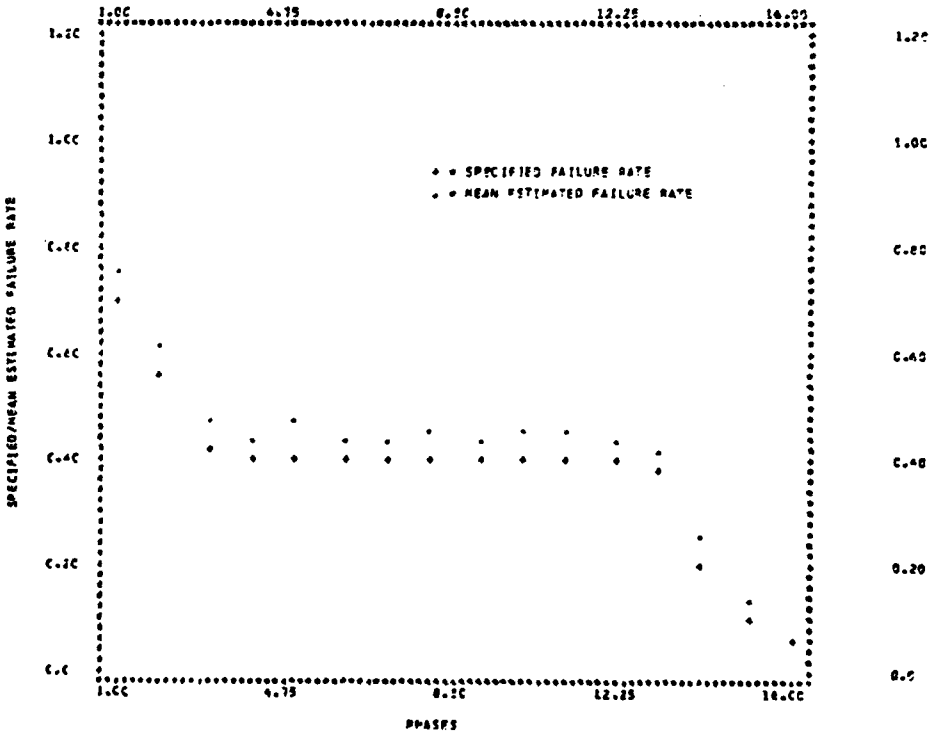


CASE 4

20 TRIPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.5000	0.4250	0.4050	0.4000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2955	0.3824	0.4013	0.4063	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.7576	0.6195	0.4855	0.4428	0.4275	0.4449	0.4455	0.4476
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	8.23	12.63	14.22	9.33	10.39	11.22	11.38	11.90
SAMPLE STD DEVIATION	0.4180	0.3404	0.2597	0.2565	0.3132	0.2414	0.2085	0.2144
CUMULATIVE TEST TIME	4.213	9.758	16.874	24.303	31.798	39.227	46.769	54.168
CUMULATIVE FAILURES	2.9500	5.8600	8.8100	11.7100	14.7100	17.6100	20.6300	23.5900

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.3750	0.2000	0.1000	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	0.4334	0.8126	1.6252	3.2504
MODEL ESTIMATE	0.4416	0.4674	0.4527	0.4400	0.4221	0.2574	0.1408	0.0665
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	10.40	16.85	13.17	10.00	12.55	28.71	40.83	33.02
SAMPLE STD DEVIATION	0.2000	0.2363	0.2373	0.2154	0.2216	0.1574	0.0957	0.0787
CUMULATIVE TEST TIME	61.674	69.133	76.672	84.172	92.154	107.194	137.320	197.432
CUMULATIVE FAILURES	27.0400	30.2200	32.8500	36.1700	35.0600	42.0600	44.8000	47.8000

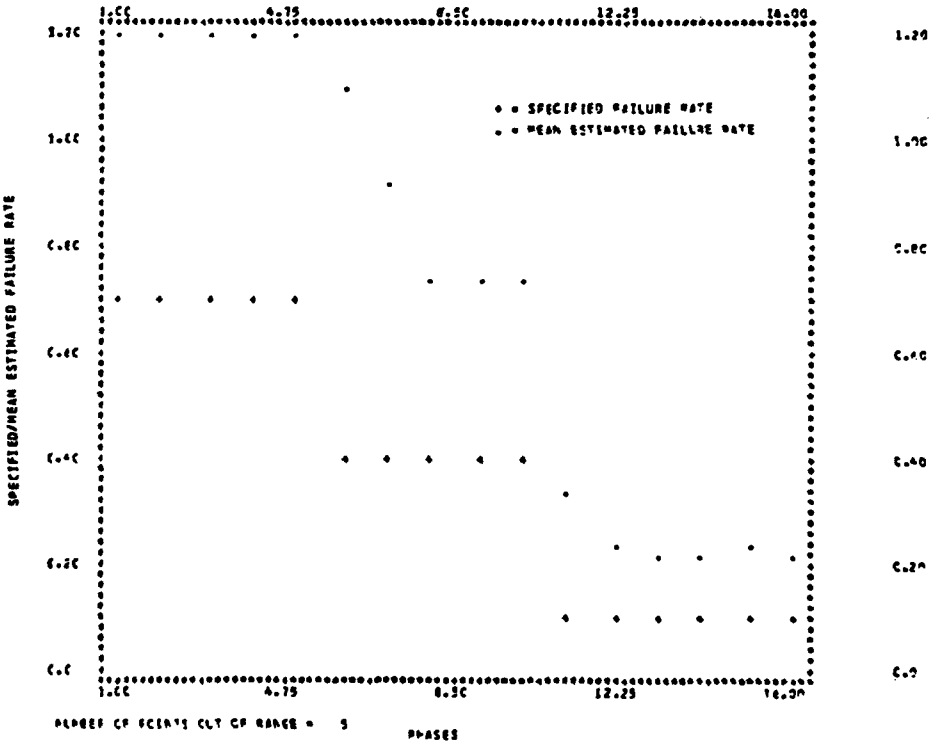


CASE 6

5 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.1000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.4063	0.4063	0.4063
MODEL ESTIMATE	1.3652	1.4414	1.3780	1.4248	1.3628	1.0920	0.9158	0.7451
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	95.03	105.91	96.85	103.54	94.68	172.99	129.64	86.27
SAMPLE STD DEVIATION	0.6434	0.8539	0.7429	0.7812	0.6593	0.3158	0.6974	0.5086
CUMULATIVE TEST TIME	1.061	2.128	3.205	4.305	5.374	7.210	9.075	10.488
CUMULATIVE FAILURES	0.7400	1.4800	2.2000	2.8400	3.4700	4.3200	4.9700	5.6900

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.4063	0.4063	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.7355	0.7320	0.3303	0.2486	0.2230	0.2152	0.2373	0.2224
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	83.89	83.01	230.34	148.63	123.04	115.18	137.33	122.42
SAMPLE STD DEVIATION	0.5162	0.5231	0.4434	0.2996	0.2061	0.1708	0.3124	0.1600
CUMULATIVE TEST TIME	12.856	14.742	22.241	29.722	37.201	44.676	52.044	59.523
CUMULATIVE FAILURES	6.6000	6.9200	7.7400	8.7300	9.6300	10.1900	10.8500	11.5000

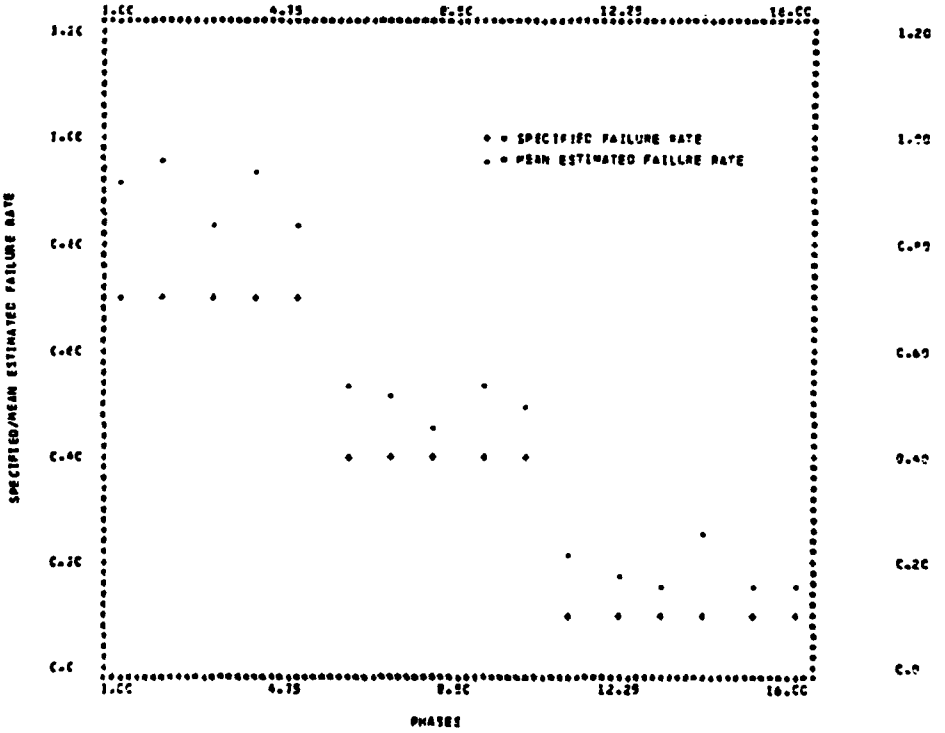


CASE 6

10 ITEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.9192	0.9590	0.8404	0.9337	0.8456	0.5467	0.5256	0.4668
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	31.32	37.00	20.05	33.38	21.37	36.67	31.41	16.69
SAMPLE STD DEVIATION	0.5076	0.5522	0.4066	0.4841	0.5002	0.4415	0.4015	0.3791
CUMULATIVE TEST TIME	2.158	4.277	6.441	8.553	10.729	14.469	18.287	22.093
CUMULATIVE FAILURES	1.5900	3.0100	4.3100	5.9200	7.0600	8.4600	9.9800	11.1700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.4063	0.4063	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.5485	0.5073	0.2168	0.1753	0.1545	0.2244	0.1553	0.1078
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	37.22	26.82	116.84	75.27	54.54	124.56	55.32	67.82
SAMPLE STD DEVIATION	0.3280	0.3046	0.2033	0.1891	0.1187	1.0256	0.0939	0.1495
CUMULATIVE TEST TIME	25.831	29.565	44.552	59.418	74.438	89.320	104.331	119.206
CUMULATIVE FAILURES	12.7500	14.0300	15.3500	17.4500	19.0200	20.5800	22.1800	23.2600

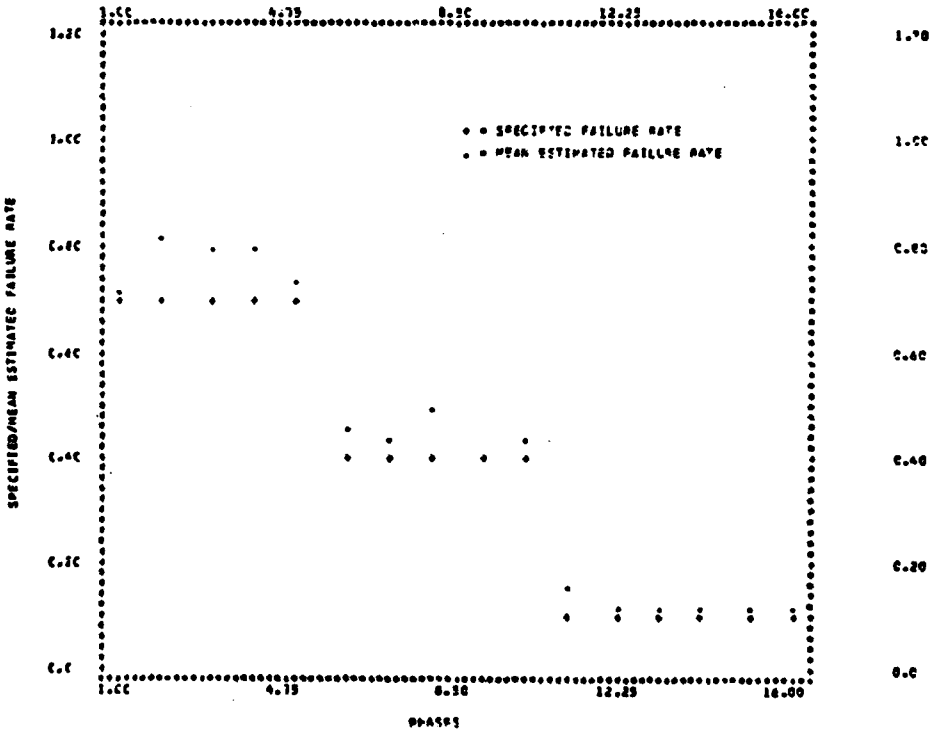


CASE 6

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.7251	0.6111	0.7970	0.7949	0.7358	0.4506	0.4486	0.4528
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	3.58	15.86	13.86	13.56	5.11	12.64	12.24	13.21
SAMPLE STD DEVIATION	0.4087	0.4101	0.3854	0.3754	0.4263	0.2427	0.1866	0.2416
CUMULATIVE TEST TIME	4.294	8.561	12.842	17.130	21.415	26.481	30.417	43.831
CUMULATIVE FAILURES	2.7700	6.0500	9.2000	12.3000	15.2100	18.0700	21.0200	24.3900

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.4063	0.4063	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.4087	0.4423	0.1478	0.1266	0.1151	0.1188	0.1273	0.1224
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	2.17	10.58	47.83	26.62	15.06	18.76	27.28	22.40
SAMPLE STD DEVIATION	0.2044	0.2269	0.1802	0.0588	0.0479	0.0375	0.0564	0.0488
CUMULATIVE TEST TIME	51.373	56.656	68.618	118.487	148.455	178.515	208.545	238.697
CUMULATIVE FAILURES	27.0300	30.0400	33.1700	36.4400	39.4300	42.5300	45.2600	48.2900

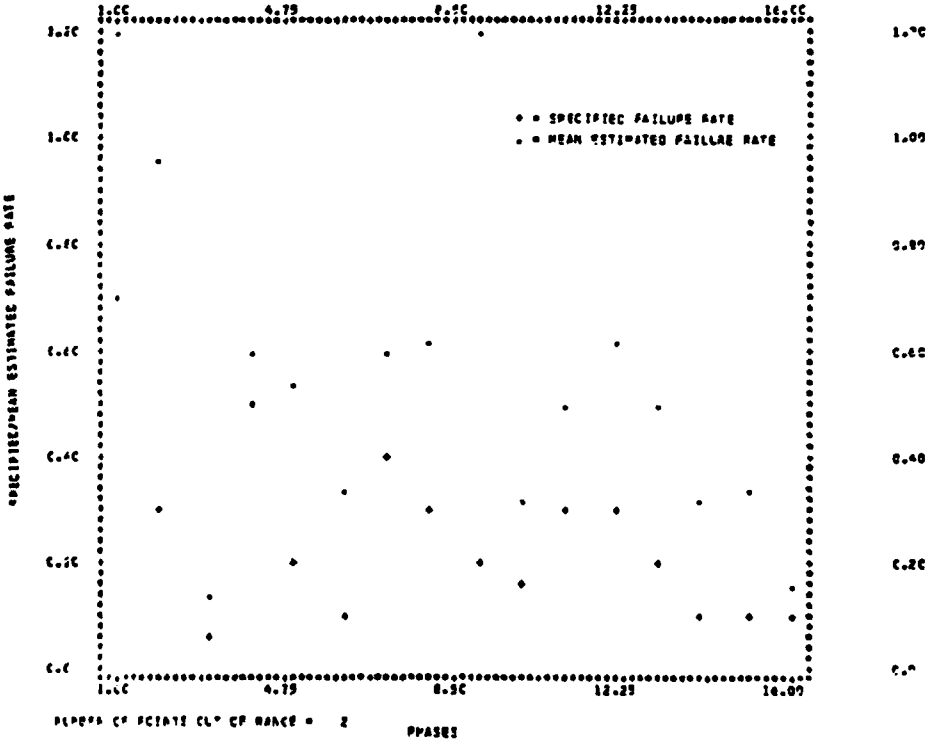


CASE 13

9 STEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.2000	0.0500	0.5000	0.2000	0.1000	0.4000	0.2000
PLANNED TEST TIME	0.2322	0.5417	3.2504	0.3250	0.8126	1.6252	0.4063	0.5417
MODEL ESTIMATE	1.5236	0.6536	0.1409	0.6078	0.5467	0.2337	0.5962	0.6176
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	117.57	217.67	181.78	21.55	173.34	233.72	49.04	133.86
SAMPLE STD DEVIATION	1.0093	0.8239	0.2124	0.5533	0.4577	0.2285	0.4937	0.4566
CUMULATIVE TEST TIME	1.074	3.573	16.481	19.990	22.722	31.229	33.112	35.979
CUMULATIVE FAILURES	0.7000	1.5000	2.1400	2.6500	3.0300	4.2700	4.6600	5.0600

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.2000	0.1500	0.3000	0.3000	0.2000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.8126	1.0825	0.5417	0.5417	0.8126	1.6252	1.6252	1.6252
MODEL ESTIMATE	2.4787	0.3158	0.4945	0.6131	0.5051	0.3279	0.3391	0.1686
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	1139.34	113.20	64.82	104.37	152.53	227.88	236.14	68.69
SAMPLE STD DEVIATION	16.8375	0.2624	0.3734	0.3696	0.3243	0.9338	1.3141	0.1967
CUMULATIVE TEST TIME	35.251	44.288	46.786	49.254	52.005	60.484	68.097	75.775
CUMULATIVE FAILURES	6.3500	7.3600	8.3100	8.7000	9.2700	10.2600	11.0700	11.1700

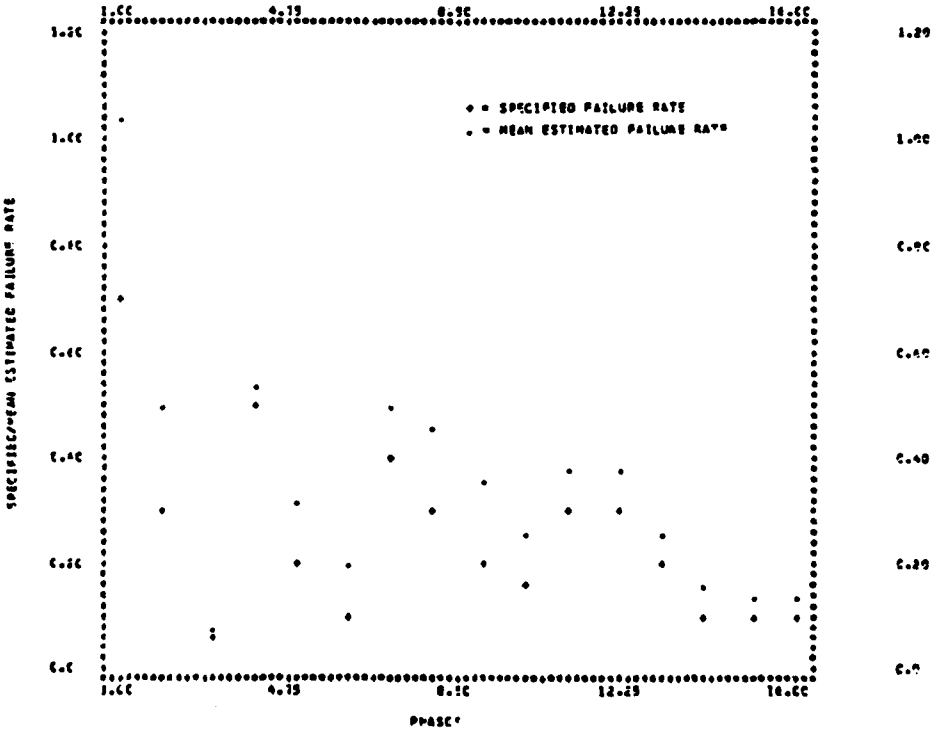


CASE 19

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.3000	0.0300	0.3000	0.2000	0.1000	0.4000	0.1000
PLANNED TEST TIME	0.2222	0.5417	3.2500	0.3250	0.8126	1.6252	0.4063	0.5417
MODEL ESTIMATE	1.0362	0.5081	0.0731	0.5402	0.3202	0.2040	0.5640	0.4673
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	48.46	69.36	46.26	8.05	60.09	103.99	29.99	99.77
SAMPLE STD DEVIATION	0.5388	0.3629	0.0726	0.4624	0.2794	0.2226	0.3755	0.2764
CUMULATIVE TEST TIME	2.184	7.083	37.101	40.109	47.606	63.376	66.304	71.262
CUMULATIVE FAILURES	1.7700	3.3500	4.8500	6.3000	7.8200	9.2700	10.9800	12.4700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.2000	0.1000	0.3000	0.3000	0.2000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.8126	1.6252	0.5417	0.5417	0.8126	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.3503	0.2534	0.3880	0.3811	0.2694	0.1693	0.1496	0.1472
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	75.16	66.94	29.34	27.04	34.71	69.39	49.62	49.22
SAMPLE STD DEVIATION	0.3430	0.2358	0.2636	0.2299	0.1952	0.1162	0.1032	0.1029
CUMULATIVE TEST TIME	76.788	88.725	93.707	98.702	100.248	121.305	136.297	151.192
CUMULATIVE FAILURES	13.6400	15.5700	16.8500	18.6800	19.6200	21.4100	23.2900	24.6700

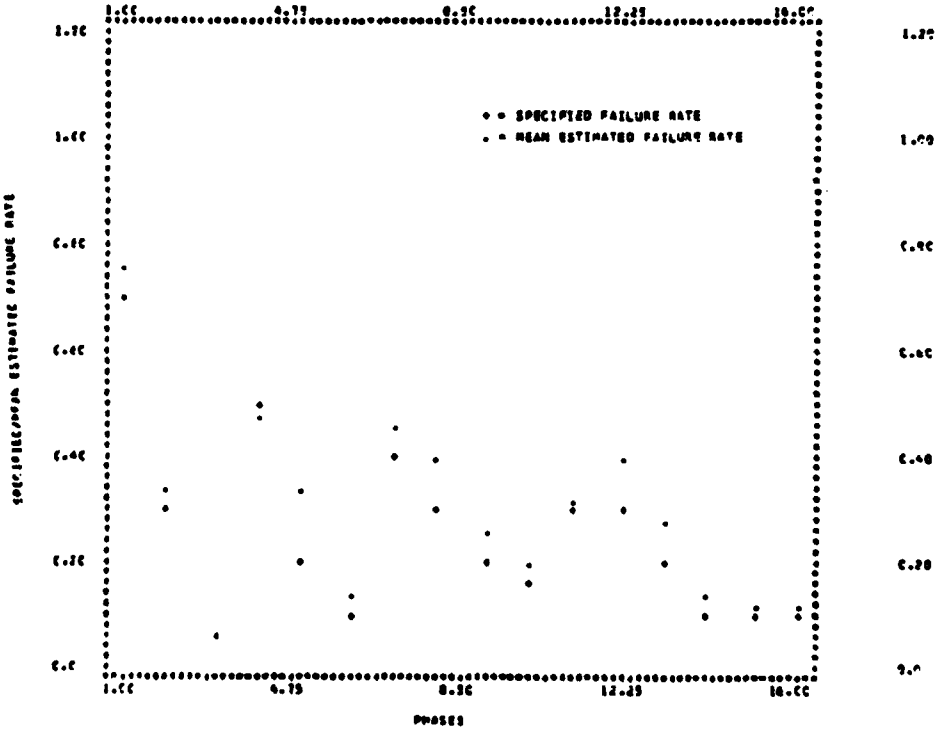


CASE 15

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.3000	0.0900	0.5000	0.2000	0.1000	0.4000	0.0900
PLANNED TEST TIME	0.2322	0.5417	3.2304	0.3250	0.8126	1.6252	0.4063	0.5417
POOLED ESTIMATE	0.7622	0.3412	0.0821	0.4766	0.2460	0.1383	0.4039	0.2518
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	8.89	13.75	24.25	4.68	73.48	38.35	13.37	30.54
SAMPLE STD DEVIATION	0.4205	0.1645	0.0376	0.3083	0.3174	0.0866	0.2624	0.7677
CUMULATIVE TEST TIME	4.272	14.388	74.686	88.098	92.034	124.411	133.746	142.278
CUMULATIVE FAILURES	2.9400	9.8500	9.8600	11.7600	14.7300	18.6500	21.9200	24.4900

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.2000	0.1500	0.3000	0.3000	0.2000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.8126	1.0835	0.5417	0.5417	0.8126	1.6252	1.6252	1.6252
POOLED ESTIMATE	0.2565	0.1941	0.3250	0.3924	0.2793	0.1346	0.1140	0.1242
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	28.23	29.40	8.34	30.80	39.66	34.59	14.18	24.24
SAMPLE STD DEVIATION	0.1418	0.1076	0.1696	0.2558	0.1836	0.0792	0.0565	0.1180
CUMULATIVE TEST TIME	157.243	177.262	187.247	197.196	212.194	242.113	273.258	282.304
CUMULATIVE FAILURES	27.4600	30.4300	33.4100	36.6600	39.6100	42.6600	45.4500	48.4900

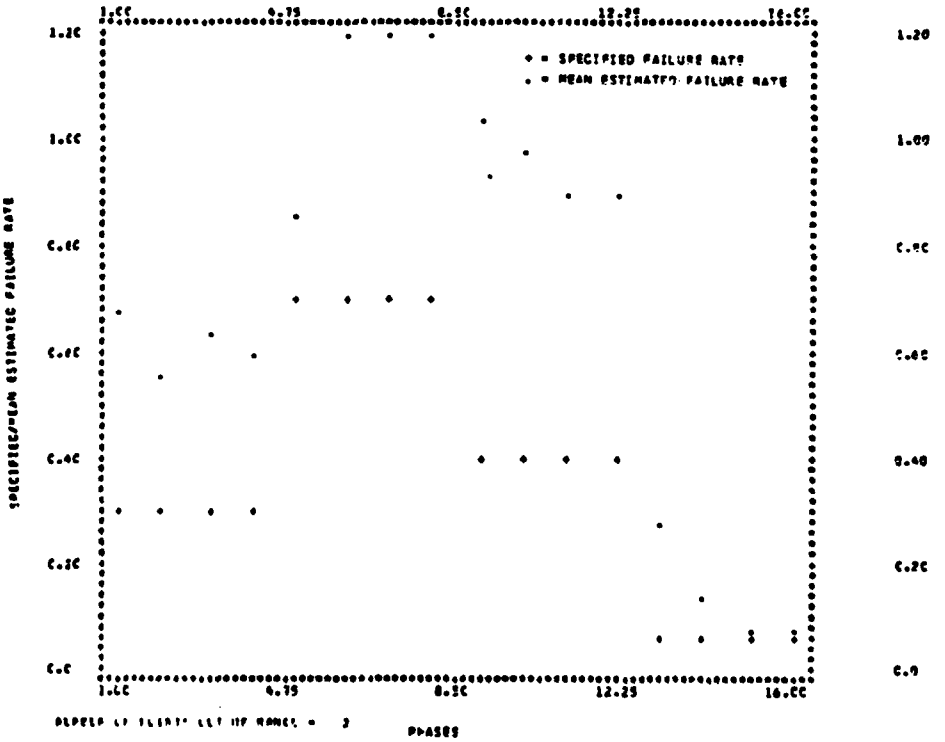


CASE 10

9 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.5417	0.5417	0.5417	0.5417	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	0.6856	0.5667	0.6498	0.5917	0.8700	1.2716	1.4143	1.4726
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	128.53	88.90	116.60	97.23	24.28	81.66	102.04	110.37
SAMPLE STD DEVIATION	0.3624	0.3011	0.3508	0.4396	0.7138	0.8571	0.8968	0.8529
CUMULATIVE TEST TIME	2.509	5.042	7.507	10.020	11.116	12.158	13.223	14.288
CUMULATIVE FAILURES	0.7100	1.4200	2.2100	2.7800	3.3600	4.2700	4.8100	5.9700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	1.0469	0.9850	0.8992	0.9081	0.2748	0.1447	0.0834	0.0719
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	161.72	147.24	124.81	127.02	449.56	189.42	66.77	43.88
SAMPLE STD DEVIATION	0.7404	0.6487	0.5733	0.6434	0.2971	0.2137	0.1450	0.0665
CUMULATIVE TEST TIME	16.166	18.057	19.541	21.804	36.765	51.570	67.164	82.335
CUMULATIVE FAILURES	6.3600	7.4500	7.6900	8.6900	9.7800	10.4600	11.0600	11.5100

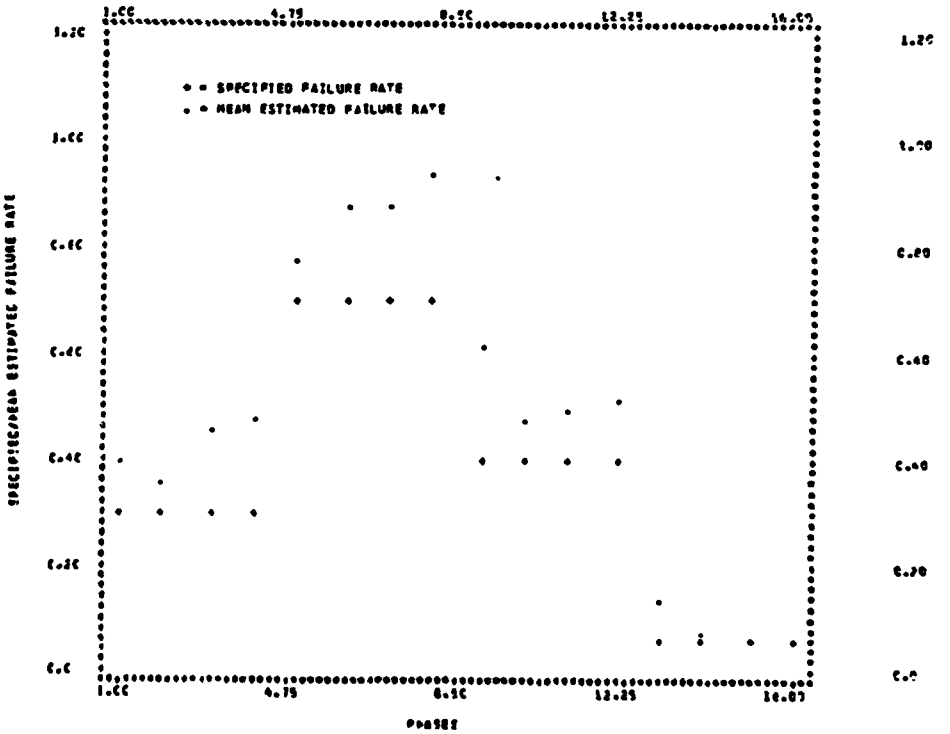


CASE 18

18 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.5417	0.5417	0.5417	0.5417	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	0.4091	0.3625	0.4506	0.4797	0.1065	0.0861	0.0776	0.0677
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	36.36	20.83	50.21	59.89	13.08	13.78	22.24	32.33
SAMPLE STD DEVIATION	0.2150	0.2511	0.2874	0.2759	0.4851	0.0265	0.0265	0.0064
CUMULATIVE TEST TIME	4.927	9.932	14.858	19.747	21.909	24.001	26.213	28.341
CUMULATIVE FAILURES	1.5000	3.0000	4.7300	6.5600	7.4406	9.0000	10.2100	12.4700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.6137	0.4838	0.4971	0.5100	0.1312	0.0745	0.0607	0.0559
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	53.42	20.94	24.28	27.50	162.43	48.98	21.40	11.83
SAMPLE STD DEVIATION	0.4341	0.3364	0.3328	0.3241	0.1774	0.1076	0.0658	0.0497
CUMULATIVE TEST TIME	32.125	35.950	39.705	43.459	72.610	103.736	132.795	161.584
CUMULATIVE FAILURES	13.6700	15.0600	16.4200	17.6700	19.1700	20.8400	22.0400	23.6200

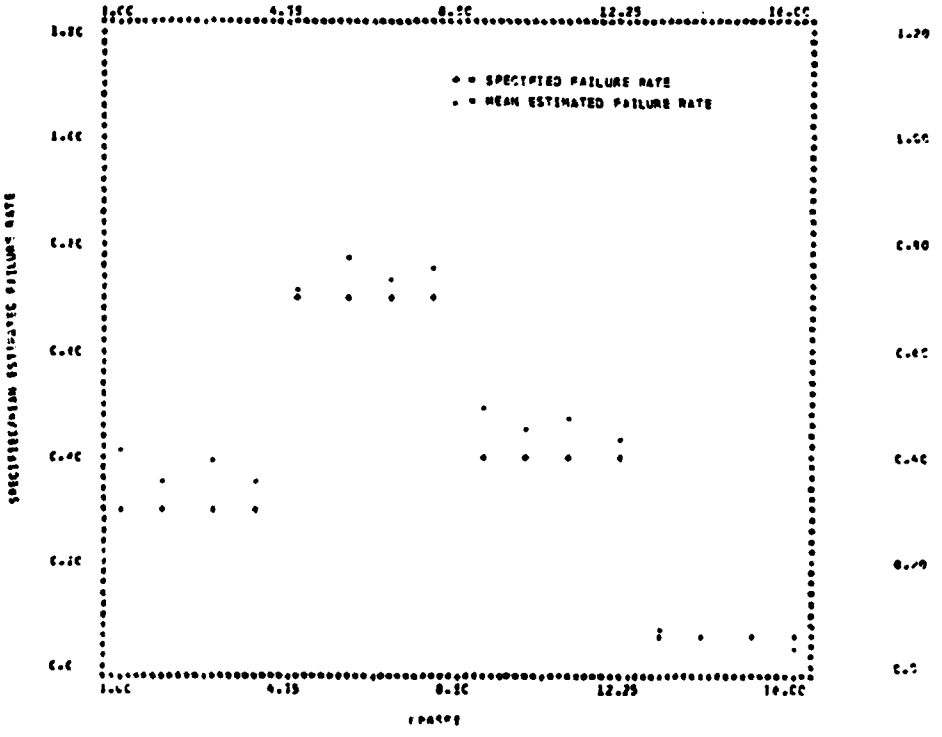


CASE 10

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.7000	0.7000	0.7000	0.7000
PLANNED TEST TIME	0.5417	0.5417	0.5417	0.5417	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	0.4185	0.3218	0.4095	0.3681	0.7206	0.7865	0.7496	0.7902
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	39.49	17.25	36.50	22.76	2.94	12.36	7.08	7.17
SAMPLE STD DEVIATION	0.2905	0.1670	0.2566	0.1911	0.3467	0.4426	0.4265	0.3909
CUMULATIVE TEST TIME	5.696	19.584	25.898	35.508	44.206	48.415	52.744	57.096
CUMULATIVE FAILURES	3.0300	9.4000	9.1800	12.0600	14.8100	17.5900	21.0300	23.9900

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.5097	0.4649	0.4842	0.4427	0.0837	0.0521	0.0524	0.0482
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	27.42	16.24	21.05	10.66	67.30	4.19	4.85	3.66
SAMPLE STD DEVIATION	0.3713	0.2430	0.2403	0.2282	0.0963	0.0321	0.0289	0.0215
CUMULATIVE TEST TIME	64.565	72.651	79.547	87.097	147.563	208.236	267.736	327.823
CUMULATIVE FAILURES	26.9100	29.8600	33.1100	36.0300	38.2000	41.5400	44.6200	47.9000



APPENDIX D

Results of Test MOD2

1. Test MOD2

Test MOD2 used the AMSAA model to estimate the failure rate of the items tested except as described below. A more detailed discussion of the modification can be found in Section V-D.

Use of the AMSAA model was modified as follows:

a. The point estimate of the failure rate,

$$r_p = \frac{\text{number of failures during a phase}}{\text{total test time during a phase}} ,$$

was used whenever cumulative test time over all items was less than 10 hours.

b. The slope of the reliability growth pattern was estimated using the current point estimate, r_p, and the previous estimate, $\hat{r}_{i-1}$, of the failure rate as follows:

$$\text{SLOPE} = r_p - \hat{r}_{i-1} .$$

Increasing slope was then determined from the following relationship:

$$r_p - \hat{r}_{i-1} \geq .2\hat{r}_{i-1} ,$$

If the slope was increasing, the point estimate, r_p, was used as the current estimate of the failure rate. Then, the AMSAA model was reinitialized, that is, time and failures prior to an increasing slope were not considered in future estimates made by the model.

2. The Results

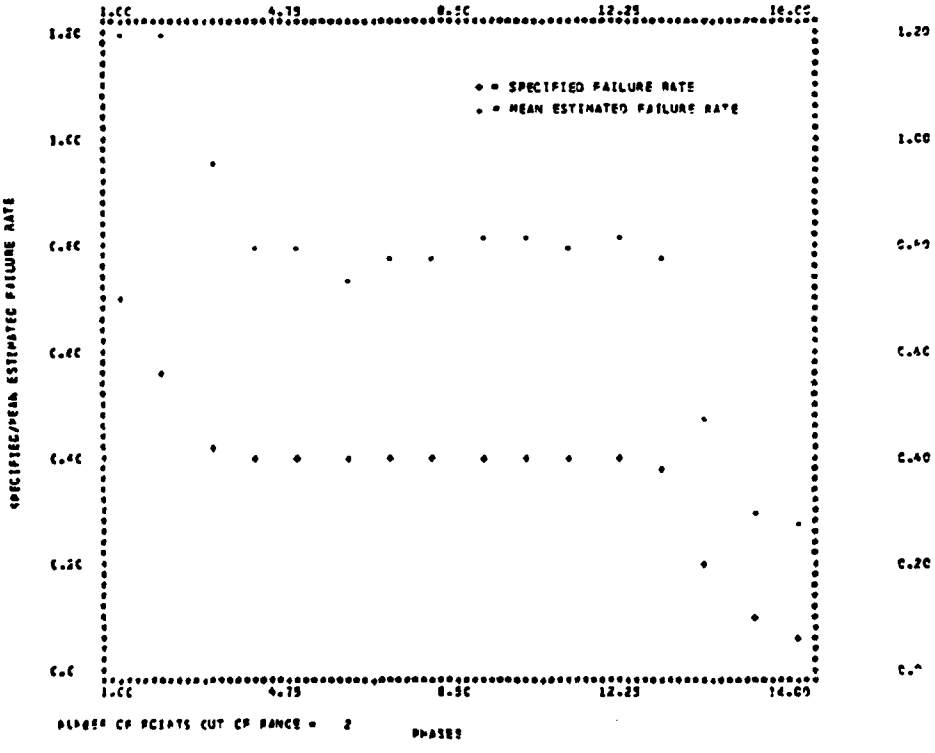
Results for Cases 4, 6, 15, and 18 are presented here as representative of the effect the modifications had on the performance of the model. A detailed description of the format of the results can be found in Appendix A.

CASE 4

9 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	C.7CCC	0.55C0	0.4250	C.405C	C.4CCC	0.4CCC	C.4CCC	0.4CCC
PLANNED TEST TIME	0.2222	0.2555	0.3824	C.4013	C.4C63	0.4C63	0.4C63	C.4C63
MODEL ESTIMATE	1.3264	1.3166	0.9675	C.8075	C.8067	0.7442	0.7787	0.7841
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	89.49	136.74	127.64	99.37	1C1.68	86.06	94.68	96.C3
SAMPLE STD DEVIATION	0.6578	0.7415	0.6545	C.6593	C.6655	0.6834	0.6941	C.6920
CUMULATIVE TEST TIME	1.C74	2.418	4.202	6.C45	7.942	9.841	11.697	13.5PC
CUMULATIVE FAILURES	C.6400	1.4CC0	2.0500	2.8900	3.5500	4.15CC	4.9CC0	5.77CC

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	C.4CCC	0.4CCC	0.4000	C.4000	C.3750	0.2C00	C.1CCC	C.0500
PLANNED TEST TIME	0.4C82	0.4C63	0.4C63	C.4063	C.4334	0.8126	1.6252	3.2504
MODEL ESTIMATE	0.8182	0.8239	0.7928	C.8124	C.7898	0.4846	0.2906	0.2921
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	104.55	105.98	98.21	103.11	11C.62	142.26	190.57	484.13
SAMPLE STD DEVIATION	0.4992	0.4621	0.4572	C.7451	C.7571	0.4203	0.3418	1.0446
CUMULATIVE TEST TIME	15.442	17.319	19.186	21.049	23.C79	24.88C	34.326	49.3C4
CUMULATIVE FAILURES	6.4400	7.1100	7.7800	8.3600	9.17CC	1C.CEC0	1C.49C0	11.58CC

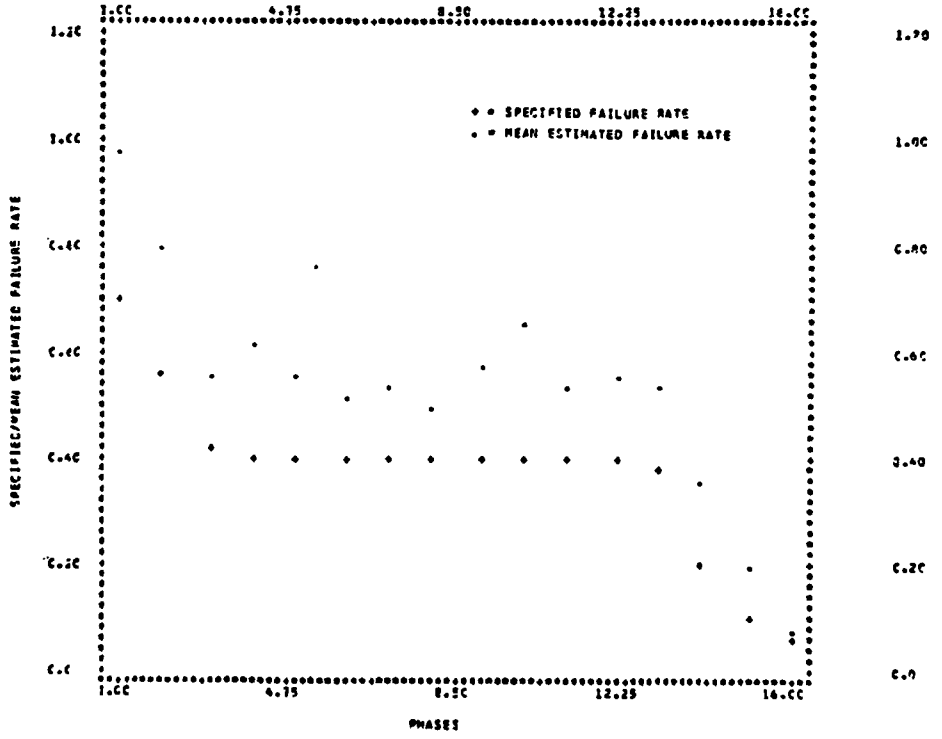


CASE 4

10 ITEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.5000	0.4250	0.4050	0.4000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2559	0.3824	0.4013	0.4063	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.9736	0.7446	0.5631	0.6279	0.5517	0.5162	0.5332	0.4692
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	39.13	44.48	32.50	54.94	37.92	29.06	33.24	17.29
SAMPLE STD DEVIATION	0.6085	0.5476	0.3305	0.6033	0.2743	0.3771	0.3627	0.3044
CUMULATIVE TEST TIME	2.136	4.667	8.462	12.133	16.883	16.633	23.410	27.196
CUMULATIVE FAILURES	1.5400	2.8500	4.1100	5.7400	7.1600	8.4100	10.1000	11.4100

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.3750	0.2000	0.1000	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	0.4334	0.8126	1.6252	3.2504
MODEL ESTIMATE	0.5740	0.6525	0.5374	0.5670	0.5484	0.3601	0.1960	0.0894
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	43.51	63.11	34.35	41.75	46.23	80.04	95.98	78.71
SAMPLE STD DEVIATION	0.3474	1.6996	0.3229	0.3362	0.3533	0.2851	0.1523	0.0582
CUMULATIVE TEST TIME	30.642	34.723	38.459	42.187	46.178	53.427	68.985	98.201
CUMULATIVE FAILURES	12.9700	14.4500	16.0100	17.2200	18.8200	20.5800	22.1900	23.9300

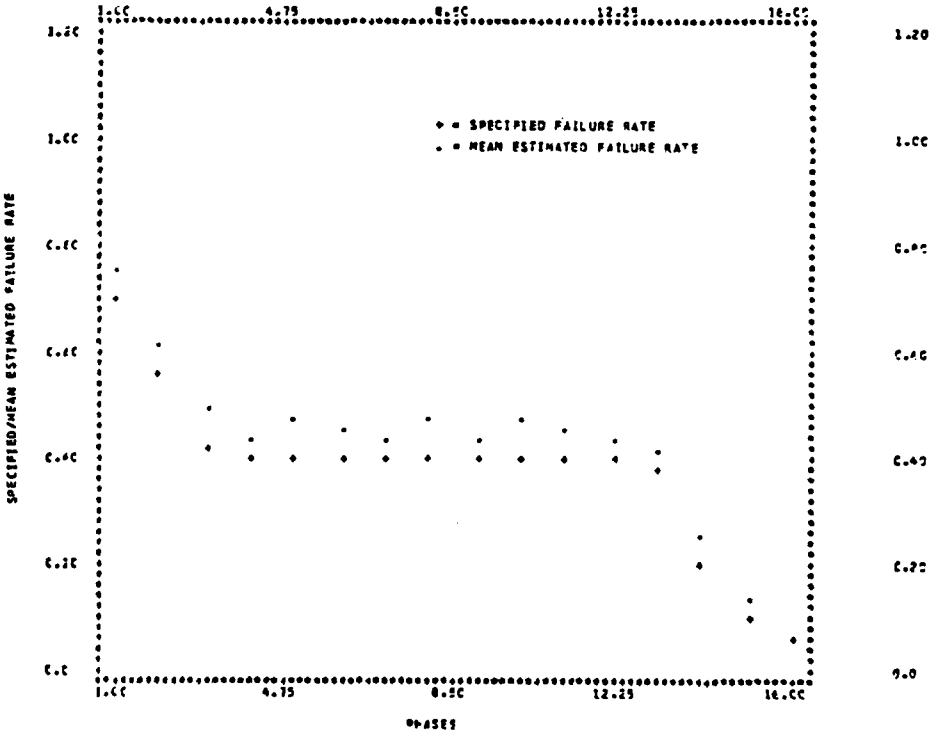


CASE 4

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.5500	0.4250	0.4050	0.4000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2555	0.3824	0.4013	0.4063	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.7576	0.6134	0.5010	0.4458	0.4752	0.4507	0.4448	0.4703
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	8.23	11.53	17.88	10.07	18.81	12.67	11.19	17.56
SAMPLE STD DEVIATION	0.4180	0.3452	0.2728	0.2616	0.3128	0.2457	0.2144	0.2141
CUMULATIVE TEST TIME	4.313	9.758	16.874	24.303	31.798	39.327	46.769	54.188
CUMULATIVE FAILURES	2.9500	5.8600	8.8700	11.7100	14.7100	17.6100	20.8300	23.5500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.3750	0.2000	0.1000	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	0.4334	0.8126	1.6252	3.2504
MODEL ESTIMATE	0.4444	0.4709	0.4536	0.4404	0.4203	0.2571	0.1403	0.0696
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	11.11	17.72	13.40	10.10	12.07	28.53	40.30	39.22
SAMPLE STD DEVIATION	0.2009	0.2357	0.2262	0.2134	0.2216	0.1556	0.0943	0.0502
CUMULATIVE TEST TIME	61.676	69.122	76.672	84.172	92.194	101.194	117.320	149.437
CUMULATIVE FAILURES	27.0400	30.2200	32.8500	36.1700	39.0600	42.0400	44.8000	47.8000

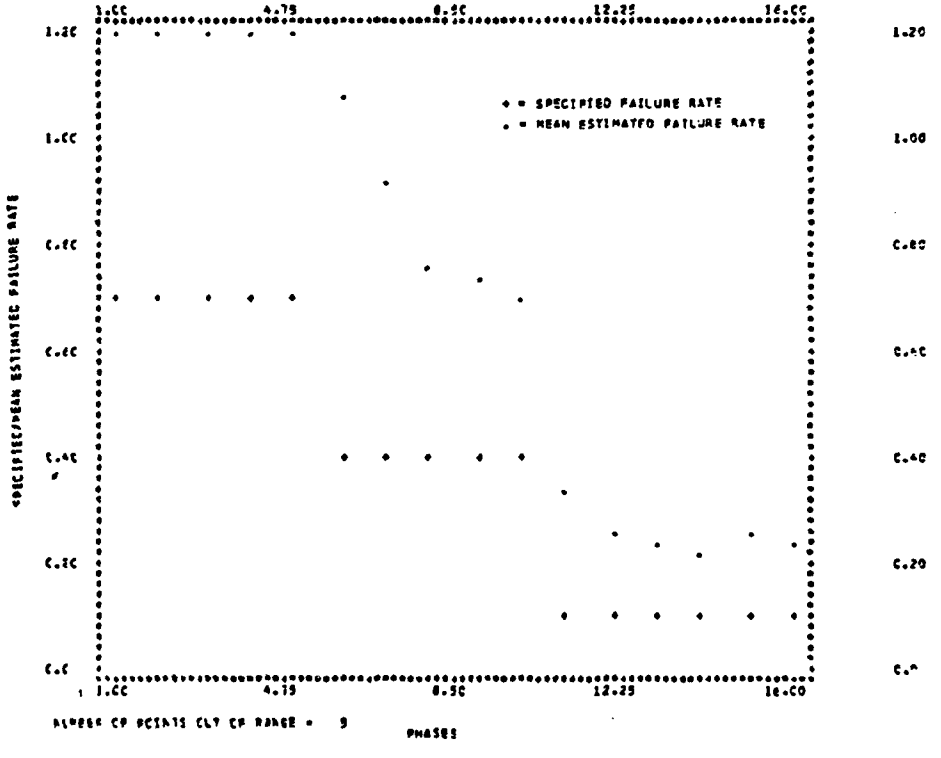


CASE 6

9 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.1000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.4063	0.4063	0.4063
MODEL ESTIMATE	1.3652	1.4585	1.3739	1.4043	1.3421	1.0711	0.9797	0.7634
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	95.03	108.36	96.28	100.61	91.72	167.77	128.42	90.10
SAMPLE STD DEVIATION	0.6434	0.8648	0.7531	0.7801	0.6943	0.7167	0.6788	0.4696
CUMULATIVE TEST TIME	1.061	2.128	3.289	4.305	5.374	7.210	9.075	10.488
CUMULATIVE FAILURES	0.7400	1.4100	2.1100	2.8400	3.4700	4.4200	4.9600	5.3500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.4063	0.4063	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.7356	0.7056	0.3340	0.2607	0.2375	0.2262	0.2267	0.2265
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	83.85	77.35	233.65	160.72	137.47	126.17	150.67	134.90
SAMPLE STD DEVIATION	0.5135	0.5252	0.4373	0.2927	0.2092	0.1717	0.3109	0.1637
CUMULATIVE TEST TIME	12.856	14.742	22.241	29.722	37.201	44.676	52.044	59.523
CUMULATIVE FAILURES	6.6000	7.0200	7.8500	8.8300	9.6300	10.1500	10.8900	11.5100

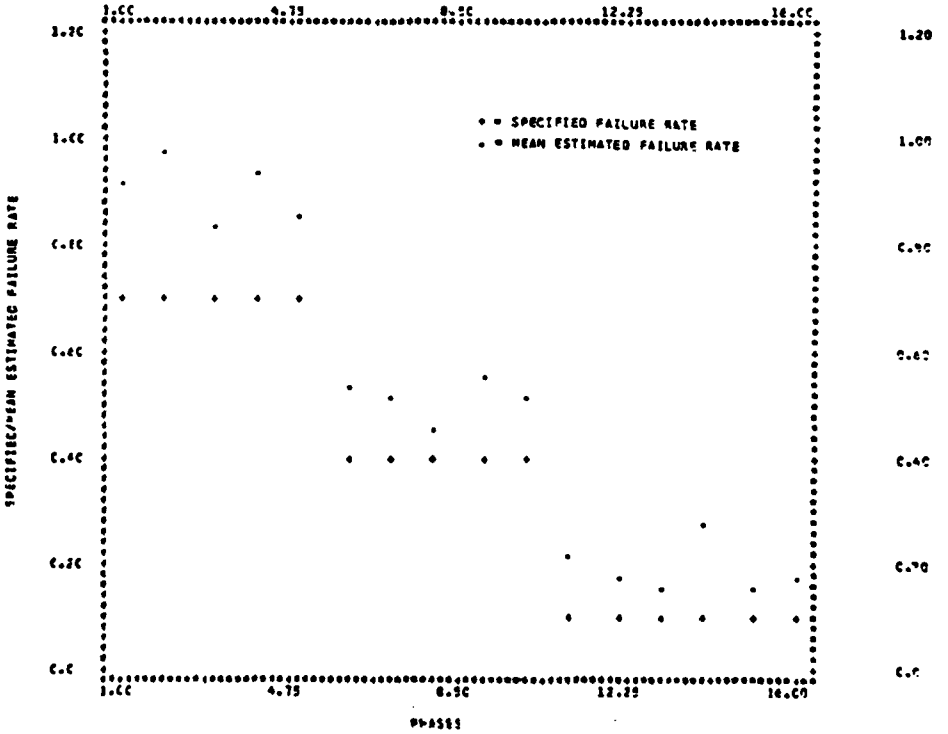


CASE 6

16 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.9192	0.9703	0.8404	0.9337	0.8568	0.5468	0.5277	0.4544
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	31.32	38.62	20.05	33.38	22.40	36.71	31.93	13.59
SAMPLE STD DEVIATION	0.5079	0.5932	0.4066	0.4861	0.4544	0.4441	0.4024	0.2792
CUMULATIVE TEST TIME	2.158	4.277	6.441	8.553	10.725	14.495	18.267	27.097
CUMULATIVE FAILURES	1.3500	2.9500	4.3100	5.9200	7.0400	8.6600	9.9800	11.1700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.4063	0.4063	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.5524	0.5131	0.2114	0.1731	0.1586	0.2852	0.1665	0.1746
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	38.10	28.27	111.36	72.07	58.60	185.23	66.48	74.65
SAMPLE STD DEVIATION	0.3345	0.2549	0.2015	0.1854	0.1254	1.0424	0.1050	0.1505
CUMULATIVE TEST TIME	25.831	29.565	44.552	59.418	74.438	85.320	104.231	119.306
CUMULATIVE FAILURES	12.7500	13.9400	15.3500	17.4500	19.0200	20.4100	22.1600	22.7700

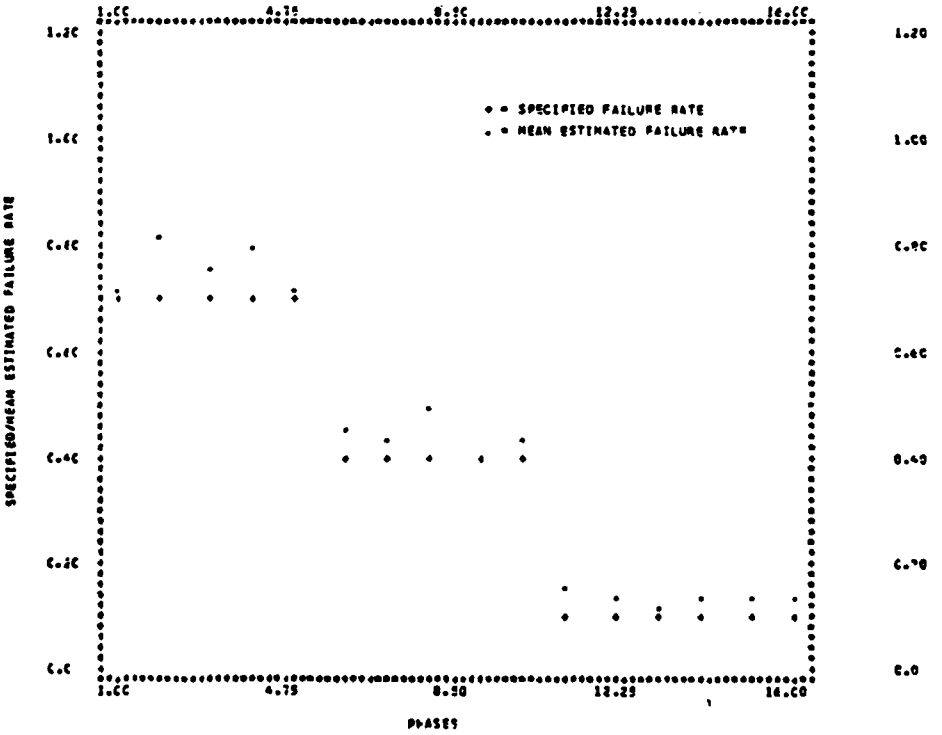


CASE 6

20 ITEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.7251	0.8171	0.7619	0.7920	0.7287	0.4545	0.4458	0.4441
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	3.58	16.72	8.84	13.14	4.10	13.64	11.46	11.03
SAMPLE STD DEVIATION	0.4087	0.4078	0.4044	0.3825	0.4318	0.2423	0.1882	0.2411
CUMULATIVE TEST TIME	4.254	8.561	12.842	17.130	21.419	28.905	36.410	43.891
CUMULATIVE FAILURES	2.7700	6.0000	9.2000	12.3000	15.2100	18.0700	21.0200	24.3000

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.4063	0.4063	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.4030	0.4359	0.1645	0.1306	0.1220	0.1265	0.1282	0.1206
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	0.74	9.58	64.48	30.57	21.98	26.52	28.19	20.67
SAMPLE STD DEVIATION	0.2055	0.2249	0.1760	0.0585	0.0487	0.1138	0.1131	0.0685
CUMULATIVE TEST TIME	51.373	58.656	86.818	118.487	146.456	178.515	208.545	238.637
CUMULATIVE FAILURES	27.0300	30.0600	33.1700	36.4600	39.4300	41.6700	45.2600	48.2200

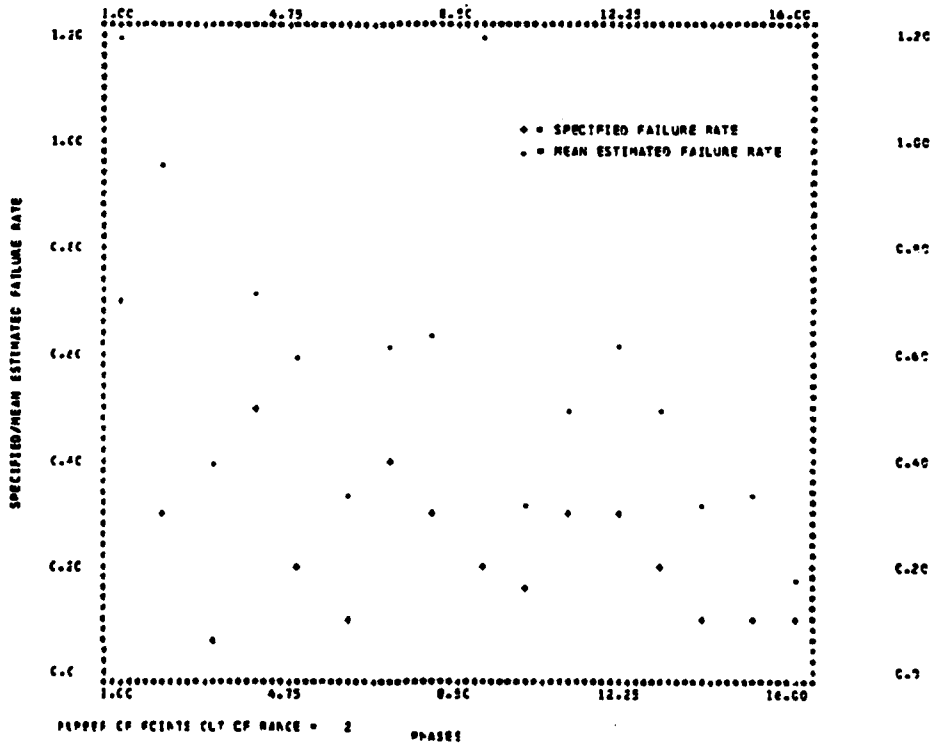


CASE 15

5 STEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.3000	0.0500	0.5000	0.2000	0.1000	0.4000	0.2000
PLANNED TEST TIME	0.2322	0.5417	3.2304	0.3250	0.8126	1.6252	0.4063	0.5417
MODEL ESTIMATE	1.5230	0.5658	0.4020	0.7188	0.5982	0.3474	0.6154	0.6282
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	117.57	223.26	711.51	43.77	199.10	247.40	53.84	191.11
SAMPLE STD DEVIATION	1.0053	0.8202	0.8308	0.4278	0.5043	0.3731	0.5041	0.4725
CUMULATIVE TEST TIME	1.074	3.279	10.481	19.990	23.722	31.225	33.112	35.975
CUMULATIVE FAILURES	0.7000	1.4000	2.1000	2.9300	3.9100	4.3200	4.6600	5.7000

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.2000	0.1500	0.3000	0.3000	0.2000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.8126	1.0835	0.5417	0.5417	0.8126	1.6252	1.6252	1.6252
MODEL ESTIMATE	2.9016	0.3201	0.4580	0.6164	0.4992	0.3215	0.3405	0.1782
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	1150.80	113.39	66.01	105.46	149.59	221.54	240.53	78.24
SAMPLE STD DEVIATION	15.8357	0.2558	0.3740	0.3707	0.3226	0.5710	1.3138	0.1617
CUMULATIVE TEST TIME	39.351	44.268	46.766	49.254	53.005	60.484	68.097	79.729
CUMULATIVE FAILURES	6.3500	7.3000	8.3100	8.7000	9.5700	10.3000	11.0700	11.7200

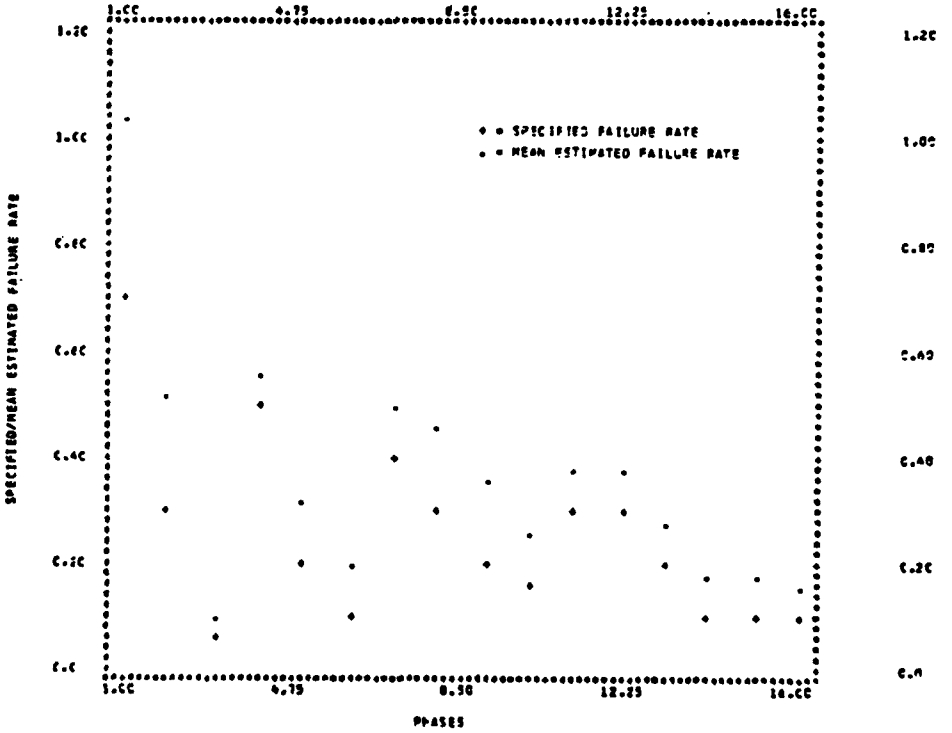


CASE 15

10 TYPES

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.3000	0.0500	0.5000	0.2000	0.1000	0.4000	0.3000
PLANNED TEST TIME	0.2332	0.5417	3.2504	0.3250	0.8126	1.6252	0.4063	0.5417
MODEL ESTIMATE	1.0352	0.5102	0.0987	0.5584	0.3268	0.1532	0.4522	0.4603
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	48.46	72.74	97.43	11.69	63.41	53.24	13.04	53.43
SAMPLE STD DEVIATION	0.5388	0.3643	0.1595	0.4639	0.2906	0.1759	0.3322	0.2694
CUMULATIVE TEST TIME	2.104	7.083	37.101	40.105	47.406	62.576	66.304	71.262
CUMULATIVE FAILURES	1.7700	3.2400	4.8500	6.3000	7.8200	9.2700	10.9600	12.4700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.2000	0.1500	0.3000	0.3000	0.2000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.8126	1.0835	0.5417	0.5417	0.8126	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.3500	0.2513	0.3859	0.3844	0.2765	0.1708	0.1700	0.1675
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	75.00	67.51	28.64	28.13	38.43	70.84	70.01	67.54
SAMPLE STD DEVIATION	0.3297	0.2239	0.2644	0.2298	0.2123	0.1212	0.1789	0.1242
CUMULATIVE TEST TIME	78.788	88.725	93.707	98.702	106.248	121.365	136.257	151.192
CUMULATIVE FAILURES	13.6500	15.5700	16.8500	18.6800	16.5200	21.4100	23.2900	24.2600

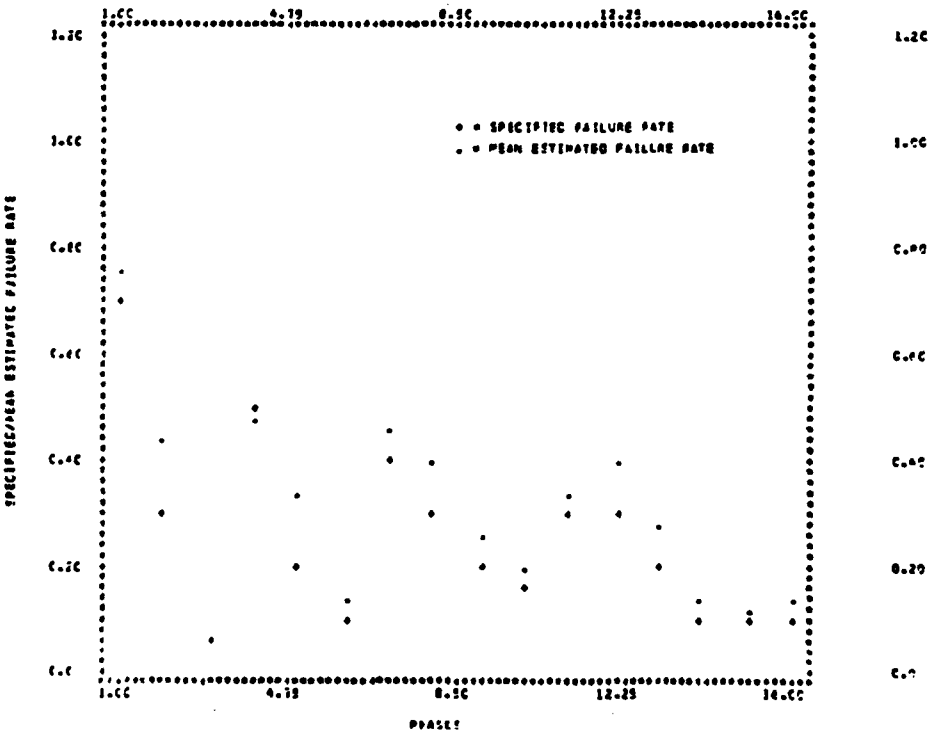


CASE 15

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.3000	0.0500	0.5000	0.2000	0.0500	0.4000	0.1000
PLANNED TEST TIME	0.2322	0.5417	3.2504	0.3250	0.8126	1.6252	0.4063	0.5417
MODEL ESTIMATE	0.7622	0.4363	0.0615	0.4776	0.3369	0.1364	0.4543	0.1422
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	8.89	44.43	22.92	4.48	68.45	36.44	13.56	30.73
SAMPLE STD DEVIATION	0.4269	0.3188	0.0390	0.3073	0.2163	0.0868	0.2614	0.2672
CUMULATIVE TEST TIME	4.272	14.388	74.066	80.098	99.034	124.911	132.346	142.278
CUMULATIVE FAILURES	2.9500	5.8100	9.0000	11.7600	14.7300	18.0500	21.3200	24.4500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.2000	0.1500	0.3000	0.3000	0.2000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.8126	1.0835	0.5417	0.5417	0.8126	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.2576	0.1585	0.3350	0.3983	0.2812	0.1403	0.1222	0.1216
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	28.85	32.33	12.95	32.77	40.60	40.34	22.18	37.67
SAMPLE STD DEVIATION	0.1616	0.1060	0.1568	0.2533	0.1828	0.0844	0.0555	0.1243
CUMULATIVE TEST TIME	157.243	177.242	187.247	197.196	212.164	242.173	272.298	302.306
CUMULATIVE FAILURES	27.4000	30.4300	33.4100	36.6600	39.6100	42.6600	45.4500	47.9700

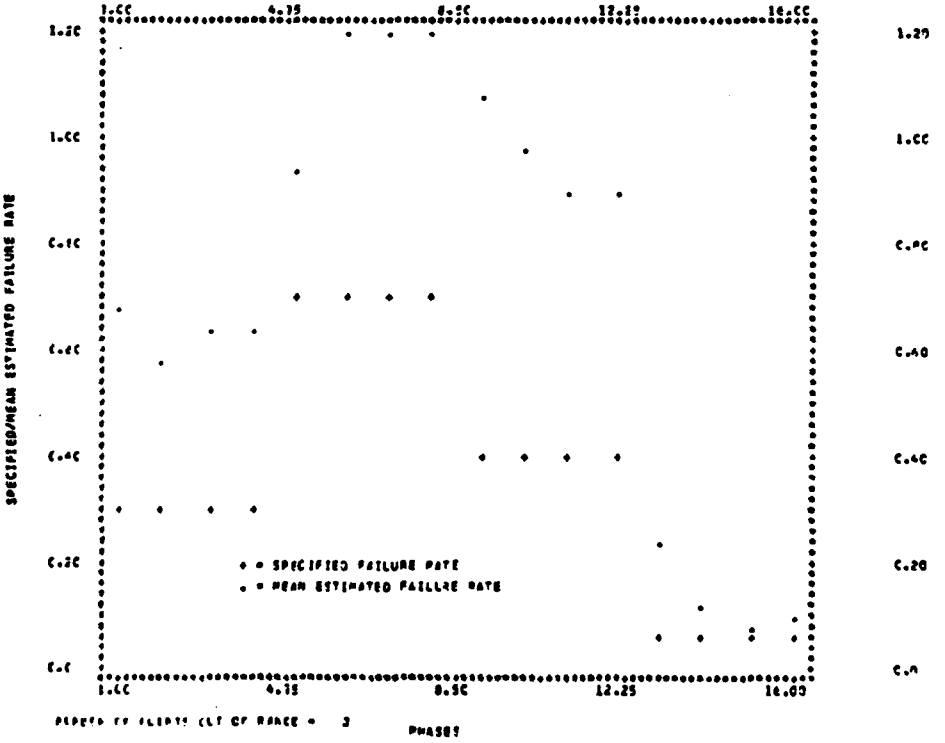


CASE 10

9 TYPE

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	C.3000	0.3000	0.3000	C.3000	C.7000	0.1000	0.7000	0.7000
PLANNED TEST TIME	0.5417	0.5417	0.5417	C.5417	C.2322	C.2322	C.2322	0.2322
MODEL ESTIMATE	0.6856	0.5759	0.6478	C.6409	C.9320	1.2916	1.4142	1.5044
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	128.53	91.96	115.95	113.64	33.14	84.52	102.02	114.91
SAMPLE STD DEVIATION	0.3824	0.3068	0.3514	C.3941	C.6545	0.8306	0.8341	C.8525
CUMULATIVE TEST TIME	2.5C9	5.042	7.587	10.020	11.119	12.158	13.223	14.286
CUMULATIVE FAILURES	0.71C0	1.33C0	2.1800	2.7800	3.34CC	4.27C0	4.94CC	5.67CC

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	C.4CCC	0.4CC0	0.4C00	C.4000	C.C500	0.05CC	C.05C0	0.0500
PLANNED TEST TIME	0.4C63	0.4C63	0.4C63	C.4063	3.25C4	3.25C4	3.25C4	3.2504
MODEL ESTIMATE	1.0843	0.98C0	0.8954	C.9058	C.2407	0.1281	0.C8e3	0.C911
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	171.Ce	145.C1	123.85	126.46	381.37	156.22	72.53	82.17
SAMPLE STD DEVIATION	0.8803	0.6514	0.6216	C.6619	C.3637	0.2458	0.1288	0.C15C
CUMULATIVE TEST TIME	16.166	18.C57	19.941	21.804	36.765	51.47C	67.164	82.335
CUMULATIVE FAILURES	6.3400	7.45CC	7.77C0	8.6900	9.78CC	10.35C0	11.09CC	11.75CC

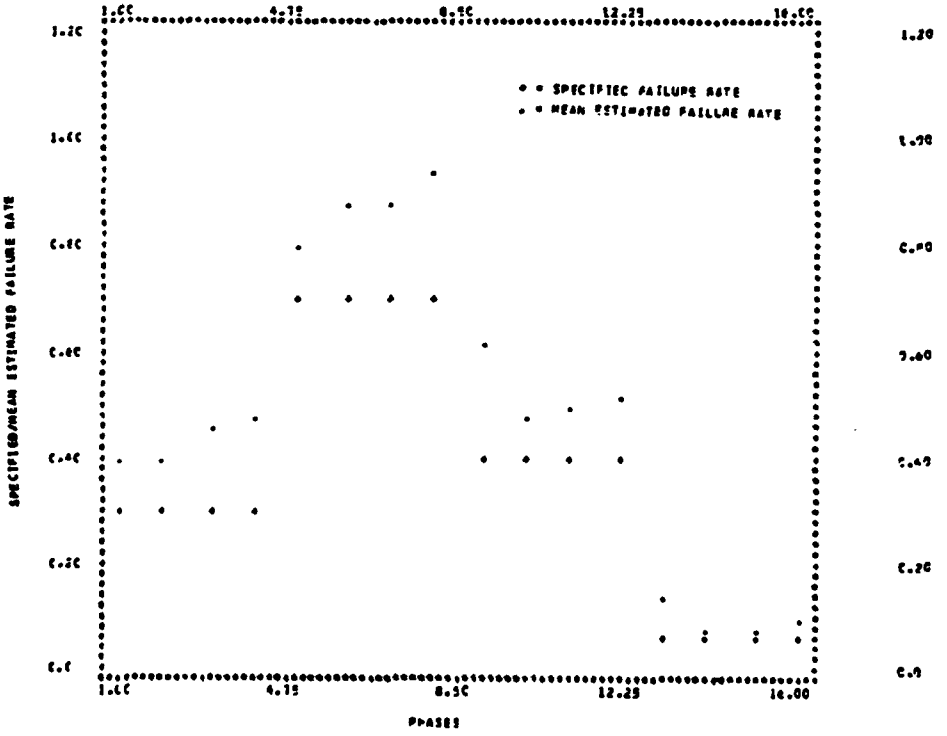


CASE 18

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.7000	0.1000	0.7000	0.7000
BLANDED TEST TIME	0.9417	0.9417	0.9417	0.9417	0.2322	0.2322	0.2322	0.2322
POOLED ESTIMATE	0.4091	0.3441	0.4504	0.4895	0.7983	0.8802	0.8770	0.9473
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	36.38	31.37	50.13	67.18	12.96	25.74	25.29	35.33
SAMPLE STD DEVIATION	0.2150	0.2343	0.2807	0.2789	0.4813	0.4284	0.5265	0.5064
CUMULATIVE TEST TIME	4.527	9.432	14.858	19.747	21.965	24.061	26.213	28.341
CUMULATIVE FAILURES	1.5900	2.9700	4.7300	6.5600	7.6700	9.0600	10.9100	12.4700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.0500	0.0900	0.0900	0.0900
BLANDED TEST TIME	0.4063	0.4063	0.4063	0.4063	3.2504	3.2504	3.2504	3.2504
POOLED ESTIMATE	0.6132	0.4787	0.4553	0.5173	0.1325	0.0797	0.0700	0.0977
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	53.31	19.67	23.82	29.33	164.55	55.48	40.10	94.28
SAMPLE STD DEVIATION	0.4347	0.3389	0.3214	0.3239	0.1755	0.1069	0.0671	0.2064
CUMULATIVE TEST TIME	32.125	35.550	39.705	43.459	73.610	103.736	133.155	163.486
CUMULATIVE FAILURES	13.6700	15.0600	16.4200	17.6700	19.1700	20.8400	22.0400	23.4100

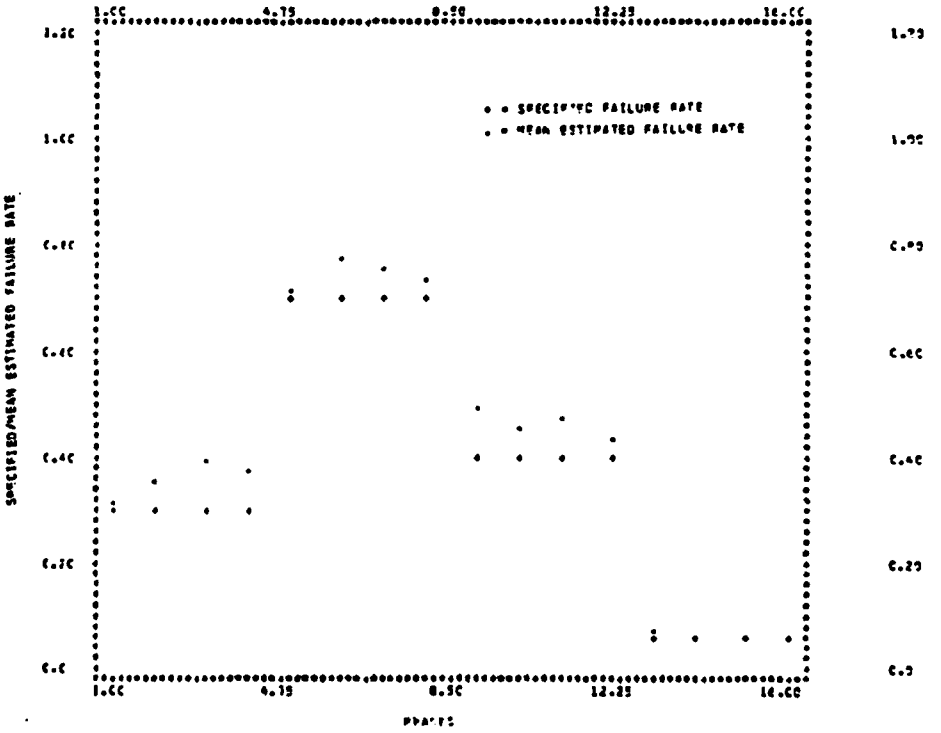


CASE 18

20 TYPES

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3CCC	0.3CC0	0.3000	C.3000	C.1CCC	C.1CCC	0.7CC0	C.7C9C
PLANNED TEST TIME	0.5417	0.5417	0.5417	C.5417	C.2322	C.2322	C.2322	C.2322
MODEL ESTIMATE	0.3215	0.3610	0.4C89	C.3709	C.1200	0.1C9C	0.7926	0.7459
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	7.16	20.34	36.29	23.62	2.86	12.72	7.91	7.13
SAMPLE STD DEVIATION	0.1615	0.2142	0.3177	C.2027	C.351C	0.4414	0.4237	C.3505
CUMULATIVE TEST TIME	9.556	19.486	29.890	39.908	44.206	48.475	52.744	57.C39
CUMULATIVE FAILURES	3.0CCC	9.CCCC	9.1CCC	12.0CCC	14.CICC	17.CCC0	21.C2CC	23.CCCC

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	C.4CCC	0.4CC0	0.4000	C.4000	C.C5C0	C.C5CC	C.C5CC	C.C*C0
PLANNED TEST TIME	0.4C63	0.4C63	0.4C63	C.4063	3.25C4	3.25C4	3.25C4	3.25C4
MODEL ESTIMATE	C.5C77	0.4640	0.4844	C.4414	C.0807	0.C547	0.0691	0.C419
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	26.92	16.C1	21.11	10.35	61.5C	9.3C	3C.2C	99.8C
SAMPLE STD DEVIATION	0.3717	0.2447	0.2372	C.2281	C.C873	0.C25C	0.0366	C.C*5C
CUMULATIVE TEST TIME	64.569	72.C51	79.547	87.C97	143.562	208.226	267.726	327.8*3
CUMULATIVE FAILURES	26.9100	29.84C0	33.11CC	36.0900	38.87CC	41.54CC	44.62CC	47.5CCC



APPENDIX E

Results of Test MOD3

1. Test MOD3

Test MOD3 used the AMSAA model to estimate the failure rate of the items tested except as described below. A more detailed discussion of the modification can be found in Section V-D.

Use of the AMSAA model was modified as follows:

a. The point estimate of the failure rate,

$$r_p = \frac{\text{number of failures during a phase}}{\text{total test time during a phase}} ,$$

was used whenever cumulative test time over all items was less than 10 hours.

b. The slope of the reliability growth pattern was estimated using the current point estimate, r_p, and the two previous estimates of the failure rate, $\hat{r}_{i-1}$ and $\hat{r}_{i-2}$. The slope estimated was in two parts,

$$\hat{r}_{i-1} - \hat{r}_{i-2} \quad \text{and} \quad r_p - \hat{r}_{i-1} ,$$

The estimate of the slope was considered increasing if both parts of the estimate were determined to be increasing as follows:

$$\hat{r}_{i-1} - \hat{r}_{i-2} \geq .07$$

and

$$r_p - \hat{r}_{i-1} \geq .07 \ .$$

If the slope was increasing, the point estimate, r_p, was used as the current estimate of the failure rate. Then, the AMSAA model was reinitialized, that is, time and failures prior to an increasing slope were not considered in future estimates made by the model.

2. The Results

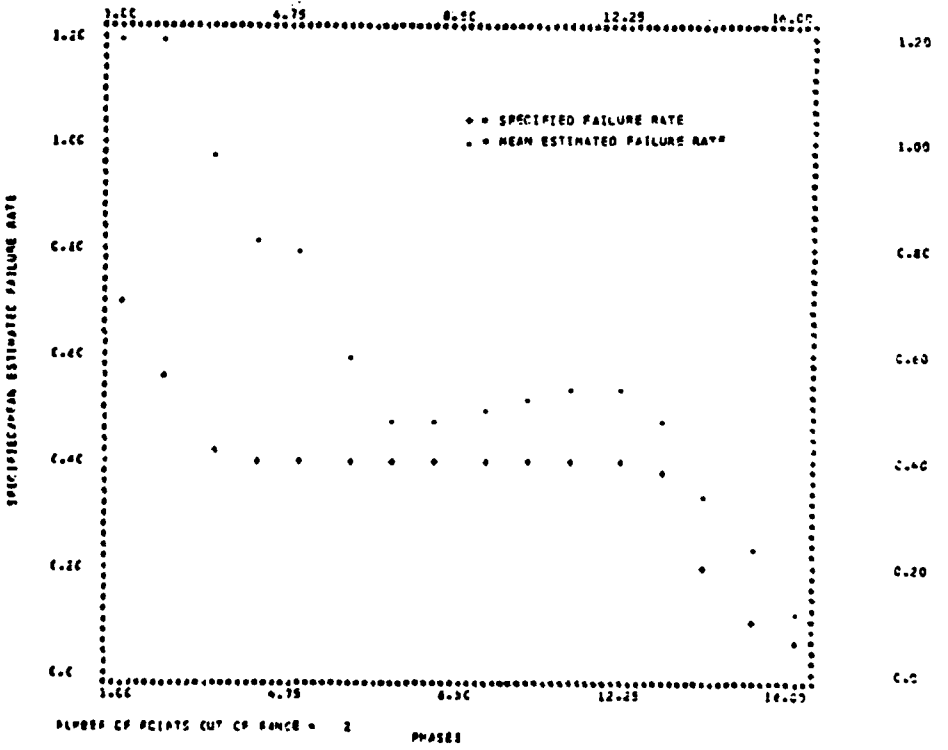
Results for Cases 4, 6, 15, and 18 are presented here as representative of the effect the modifications had on the performance of the model. A detailed description of the format of the results can be found in Appendix A.

CASE 4

9 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.5500	0.4250	0.4050	0.4000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2655	0.3624	0.4013	0.4063	0.4063	0.4063	0.4063
MODEL ESTIMATE	1.3244	1.2500	0.9888	0.8127	0.8044	0.6062	0.4842	0.4185
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	89.49	134.54	132.65	100.68	101.09	51.55	21.06	19.63
SAMPLE STD DEVIATION	0.6578	0.7256	0.6517	0.4575	0.4637	0.3258	0.2182	0.2567
CUMULATIVE TEST TIME	1.074	2.418	4.202	6.049	7.942	9.843	11.667	13.582
CUMULATIVE FAILURES	0.6400	1.5100	2.0700	2.6100	3.2500	4.2100	5.0700	5.7700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.3750	0.2000	0.1000	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	0.4334	0.8126	1.6252	3.2504
MODEL ESTIMATE	0.5034	0.5193	0.5353	0.5432	0.4831	0.3456	0.2457	0.1275
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	25.85	29.83	33.81	35.79	28.83	72.82	145.66	154.97
SAMPLE STD DEVIATION	0.3057	0.3314	0.3348	0.3906	0.3265	0.2252	0.2752	0.2814
CUMULATIVE TEST TIME	15.442	17.319	19.186	21.049	23.079	24.888	34.326	46.304
CUMULATIVE FAILURES	6.3800	7.3000	8.0700	8.3700	9.3200	10.0800	10.8500	11.5000

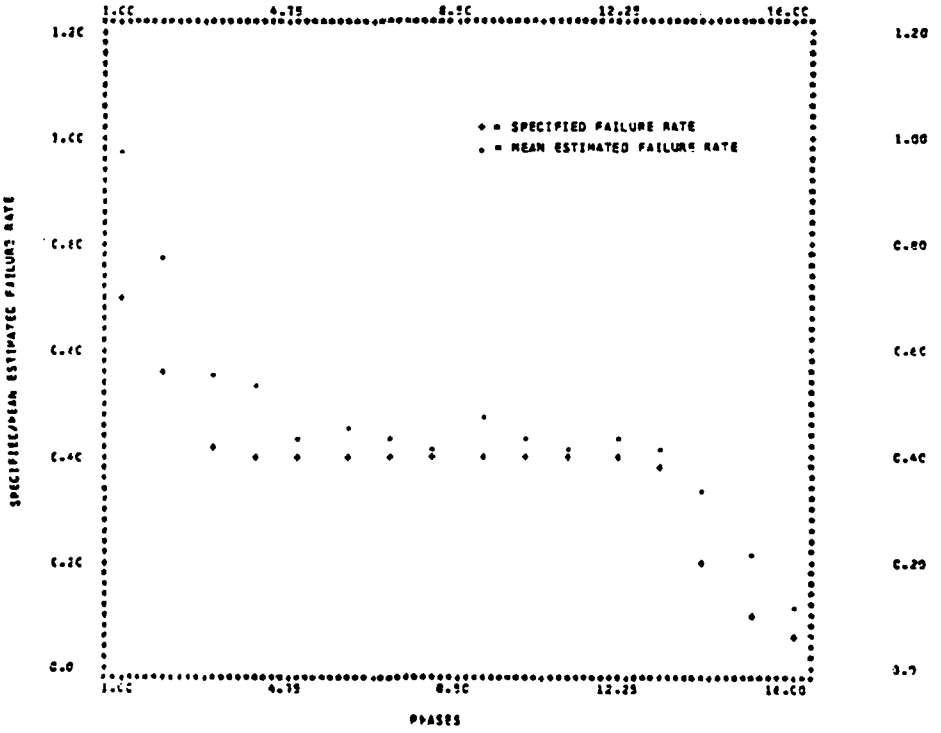


CASE 4

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.5100	0.4250	0.4050	0.4000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2555	0.3624	0.4013	0.4063	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.9739	0.7761	0.5674	0.5432	0.4428	0.4351	0.4351	0.4316
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	39.13	41.11	33.50	34.13	10.71	13.77	9.77	7.90
SAMPLE STD DEVIATION	0.6085	0.5434	0.3215	0.5243	0.2595	0.2614	0.2879	0.2205
CUMULATIVE TEST TIME	2.136	4.687	8.462	12.133	15.883	19.633	23.410	27.199
CUMULATIVE FAILURES	1.5400	2.9400	4.1400	5.8600	7.3100	8.6400	10.1000	11.3900

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.3750	0.2000	0.1000	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4062	0.4234	0.8126	1.6252	3.2504
MODEL ESTIMATE	0.4859	0.4394	0.4195	0.4298	0.4269	0.3421	0.2276	0.1269
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	21.47	9.86	4.87	9.94	13.83	71.06	127.63	153.59
SAMPLE STD DEVIATION	0.3573	0.2538	0.2260	0.2441	0.1572	0.1564	0.0538	0.0404
CUMULATIVE TEST TIME	30.543	34.123	38.459	42.187	46.178	53.627	66.565	98.201
CUMULATIVE FAILURES	13.0700	14.3100	16.0100	17.5700	19.1600	20.8000	22.3600	23.9300

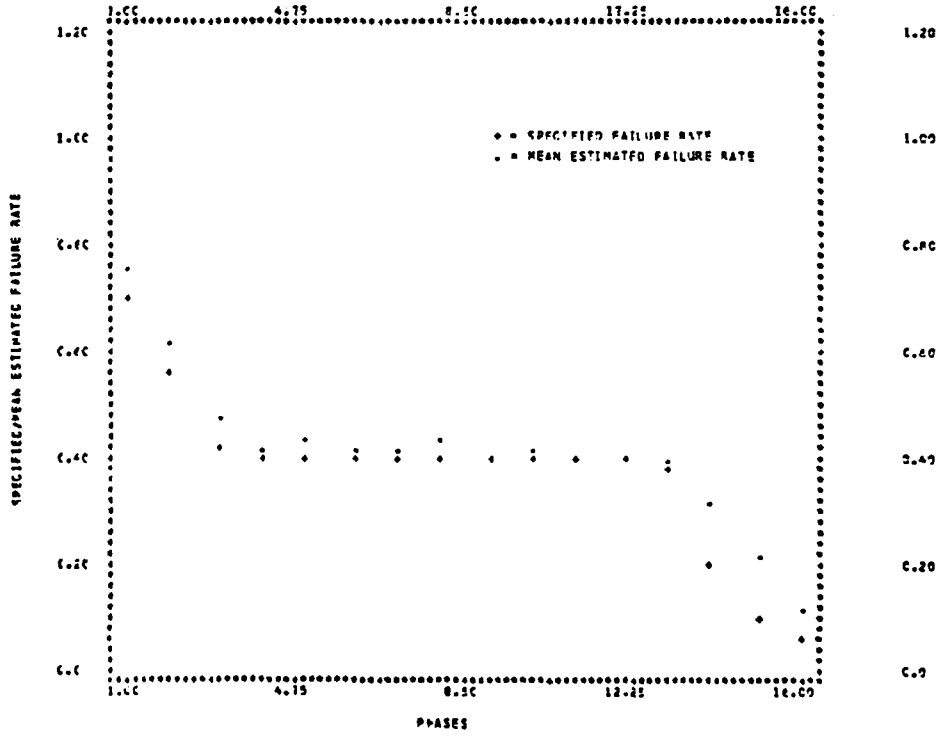


CASE 4

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.5500	0.4250	0.4050	0.4000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2525	0.3824	0.4013	0.4063	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.7576	0.6289	0.4737	0.4292	0.4348	0.4264	0.4121	0.4170
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	8.23	14.35	11.47	5.98	8.71	7.35	3.03	4.25
SAMPLE STD DEVIATION	0.4180	0.3568	0.2469	0.2077	0.2363	0.2092	0.1562	0.1784
CUMULATIVE TEST TIME	4.313	9.798	16.874	24.303	31.798	39.327	46.769	54.188
CUMULATIVE FAILURES	2.9500	5.6600	8.8100	11.7100	14.7100	17.7600	20.8300	24.0300

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.3750	0.2000	0.1000	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	0.4334	0.8126	1.6252	3.2504
MODEL ESTIMATE	0.4096	0.4167	0.3936	0.3958	0.3913	0.3106	0.2133	0.1268
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	2.39	4.17	1.59	1.04	4.34	55.31	113.25	153.63
SAMPLE STD DEVIATION	0.1432	0.1600	0.1282	0.1137	0.1154	0.0959	0.0667	0.0406
CUMULATIVE TEST TIME	61.676	69.133	76.672	84.172	92.154	107.154	127.320	197.432
CUMULATIVE FAILURES	27.0400	30.2200	33.2300	36.1700	39.0600	42.0600	44.8600	47.8000

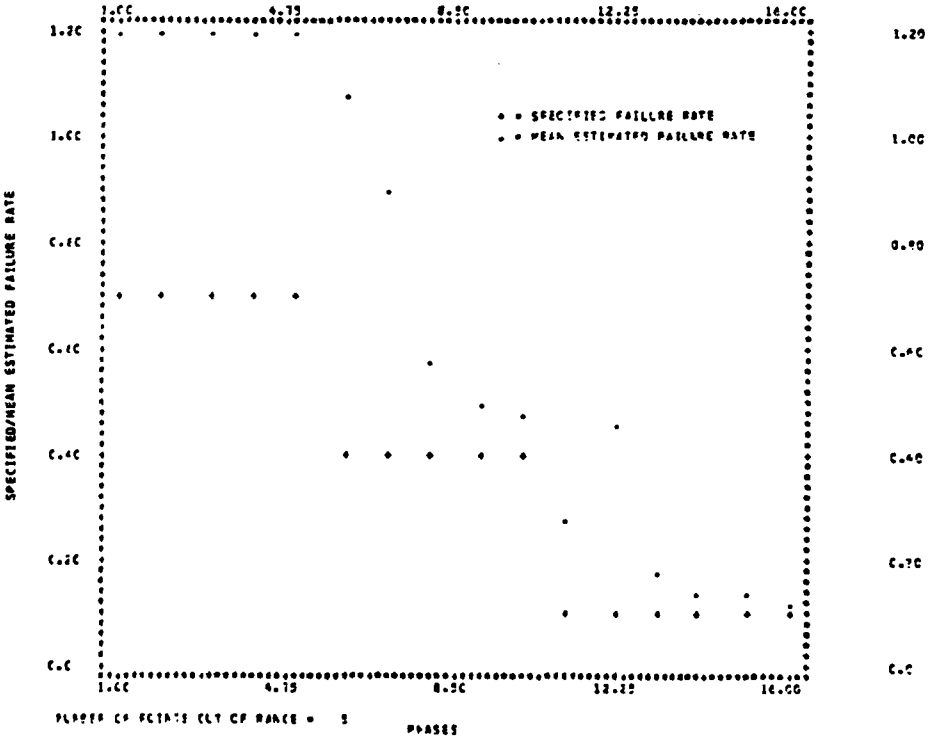


CASE 6

9 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.4063	0.4063	0.4063
MODEL ESTIMATE	1.3652	1.4414	1.3728	1.4248	1.3555	1.0810	0.9029	0.5731
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	95.03	105.91	96.11	103.54	93.64	170.24	125.72	43.27
SAMPLE STD DEVIATION	0.6434	0.8535	0.7410	0.7812	0.6901	0.7164	0.6235	0.2585
CUMULATIVE TEST TIME	1.061	2.128	3.289	4.305	5.374	7.218	9.075	10.568
CUMULATIVE FAILURES	0.7400	1.4800	2.2200	2.8400	3.5500	4.4300	5.2500	6.0100

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.4063	0.4063	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.5058	0.4751	0.2701	0.4624	0.1733	0.1458	0.1340	0.1231
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	27.46	18.77	170.15	362.37	73.35	45.78	33.50	23.08
SAMPLE STD DEVIATION	0.2716	0.2446	0.1674	2.5930	0.1390	0.1091	0.0791	0.0549
CUMULATIVE TEST TIME	12.656	14.742	22.241	29.722	37.201	44.676	52.044	59.522
CUMULATIVE FAILURES	6.6800	7.3800	7.9800	8.9000	9.7000	10.4000	11.3000	12.1500

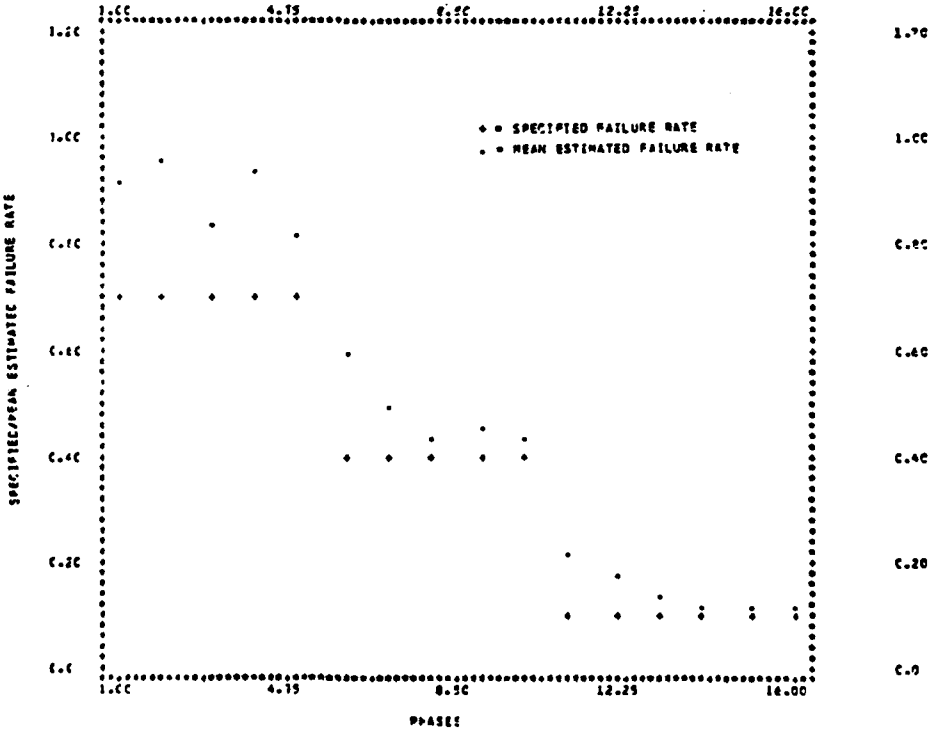


CASE 6

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2222	0.2222	0.2222	0.2222	0.2222	0.4062	0.4062	0.4062
MODEL ESTIMATE	0.9152	0.9550	0.8363	0.9337	0.8286	0.6061	0.5078	0.4483
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	31.32	37.00	19.48	33.38	18.37	51.53	26.95	12.08
SAMPLE STD DEVIATION	0.5079	0.5522	0.4067	0.4841	0.4364	0.2851	0.3367	0.2194
CUMULATIVE TEST TIME	2.158	4.277	6.441	8.553	10.729	14.499	18.287	22.093
CUMULATIVE FAILURES	1.3900	3.0100	4.3300	5.9200	7.1800	8.6600	9.9800	11.2900

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.4063	0.4063	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.4693	0.4462	0.2259	0.1702	0.1426	0.1266	0.1167	0.1107
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	17.32	11.54	125.93	70.15	42.62	26.58	16.68	10.70
SAMPLE STD DEVIATION	0.2712	0.2156	0.0606	0.0426	0.0317	0.0258	0.0257	0.0279
CUMULATIVE TEST TIME	25.831	29.569	44.552	55.418	74.438	85.320	104.331	115.308
CUMULATIVE FAILURES	12.7500	14.1900	15.7600	17.4500	19.0200	20.2600	22.1200	23.7400

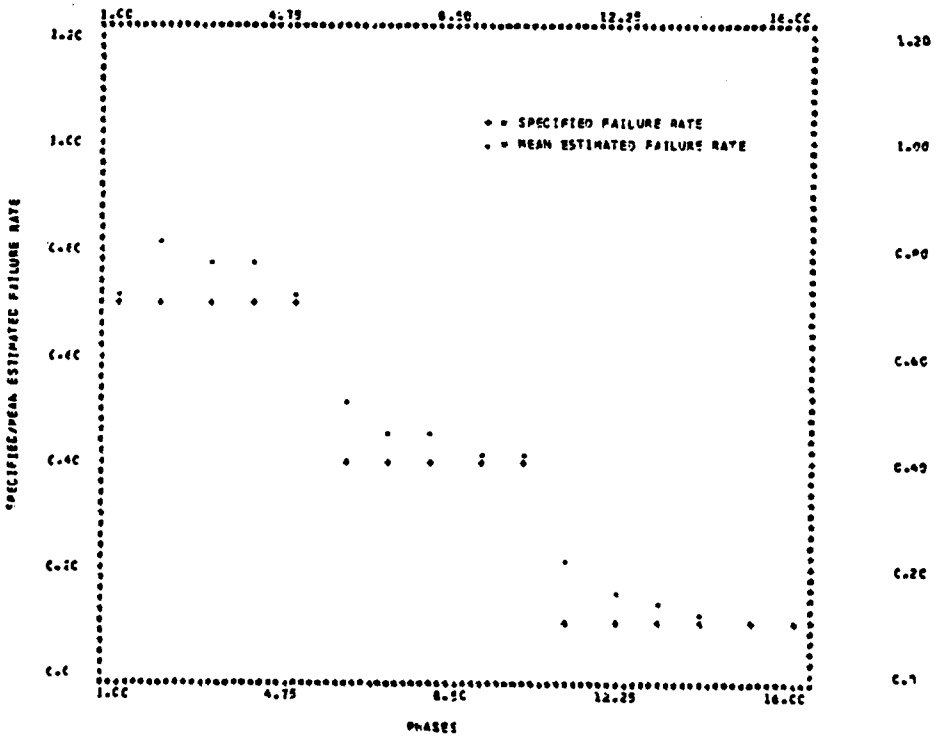


CASE 6

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.1000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.4643	0.4643	0.4643
MODEL ESTIMATE	0.7251	0.8111	0.7828	0.7842	0.7198	0.5266	0.4614	0.4524
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	3.58	15.86	11.83	12.02	2.82	31.49	15.35	13.10
SAMPLE STD DEVIATION	0.4087	0.4101	0.3469	0.3558	0.3222	0.2321	0.1817	0.1604
CUMULATIVE TEST TIME	4.264	8.561	12.842	17.130	21.415	26.509	36.410	43.831
CUMULATIVE FAILURES	2.7700	6.0500	9.2000	12.3000	15.2100	17.6500	21.0200	24.2000

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.4643	0.4643	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.4173	0.4176	0.2115	0.1607	0.1338	0.1181	0.1081	0.1005
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	4.33	4.39	111.53	60.74	33.84	18.08	8.05	0.54
SAMPLE STD DEVIATION	0.1407	0.1426	0.0741	0.0457	0.0335	0.0279	0.0235	0.0204
CUMULATIVE TEST TIME	51.373	58.656	88.618	110.457	140.455	176.515	208.245	238.637
CUMULATIVE FAILURES	27.0300	30.0400	33.1700	36.4600	39.4300	42.3500	45.2600	48.2700

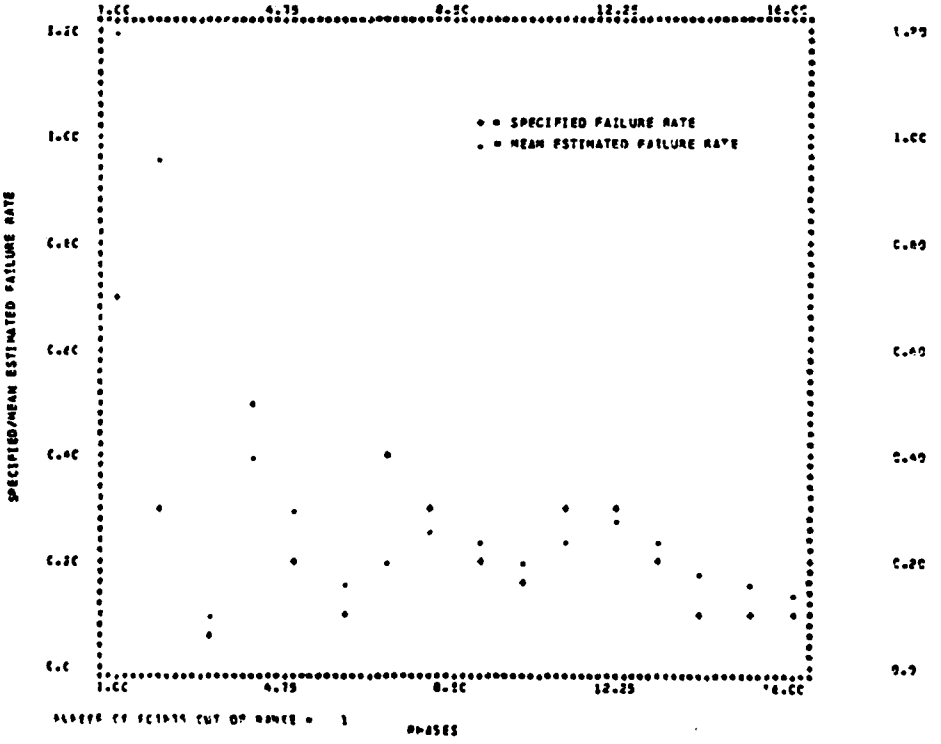


CASE 15

5 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.3000	0.0500	0.2000	0.2000	0.1000	0.4000	0.2000
PLANNED TEST TIME	0.2322	0.5417	3.2504	0.3750	0.8126	1.6252	0.4063	0.5417
MODEL ESTIMATE	1.5236	0.5539	0.1074	0.4027	0.2942	0.1174	0.1524	0.2615
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	117.37	217.97	114.79	19.47	47.10	17.40	61.89	12.70
SAMPLE STD DEVIATION	1.0053	0.8239	0.1107	0.7404	0.3842	0.1725	0.1868	0.3440
CUMULATIVE TEST TIME	1.074	3.213	18.481	19.990	23.722	31.225	33.112	35.575
CUMULATIVE FAILURES	0.7500	1.9200	2.2500	2.9500	3.7300	4.4500	5.0700	5.6300

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.2000	0.1500	0.5000	0.3000	0.2000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.8126	1.0835	0.5417	0.5417	0.8126	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.2333	0.1528	0.2456	0.2727	0.2406	0.1834	0.1516	0.1314
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	16.63	28.51	18.13	9.09	20.47	83.40	51.74	31.42
SAMPLE STD DEVIATION	0.2264	0.1616	0.2581	0.2768	0.2459	0.1295	0.0957	0.0811
CUMULATIVE TEST TIME	39.351	44.288	46.786	49.254	53.005	60.484	68.097	75.725
CUMULATIVE FAILURES	6.5100	7.2200	8.3100	9.1000	9.8100	10.7100	11.3500	11.9530

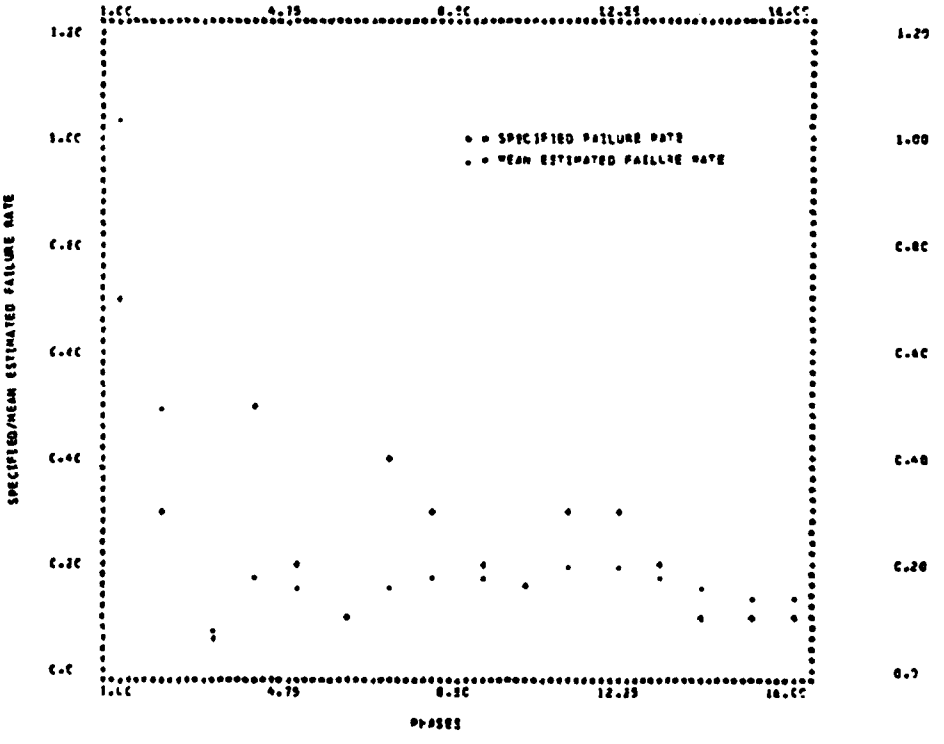


CASE 15

16 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	C.7000	0.3000	0.0500	C.5000	C.2000	0.1000	0.4000	0.2500
PLANNED TEST TIME	C.2322	0.5417	3.2504	C.3250	C.8126	1.6252	0.4063	C.5417
MODEL ESTIMATE	1.0392	0.5081	0.0843	C.1876	C.1503	0.1072	0.1500	0.1721
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	48.46	69.36	68.63	62.49	24.85	7.18	62.49	42.84
SAMPLE STD DEVIATION	0.5388	0.3629	0.1227	0.3933	C.1465	0.0610	0.1129	0.1137
CUMULATIVE TEST TIME	2.184	7.083	37.101	40.105	47.606	63.574	66.304	71.262
CUMULATIVE FAILURES	1.7100	3.3500	4.8500	6.3500	7.9200	9.3600	10.9800	12.5500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	C.2000	0.1500	0.3000	C.3000	C.2000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.8126	1.0835	0.5417	0.5417	C.8126	1.6252	1.6252	1.6252
MODEL ESTIMATE	C.1801	0.1664	0.1985	C.1981	C.1861	0.1584	C.1447	0.1338
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	9.93	10.93	33.85	33.96	6.94	58.38	44.71	33.81
SAMPLE STD DEVIATION	0.1424	0.1105	0.1573	C.1275	C.0857	0.0656	0.0531	0.0473
CUMULATIVE TEST TIME	78.788	88.725	93.707	98.702	100.248	121.305	126.357	131.162
CUMULATIVE FAILURES	13.9900	15.5100	17.1800	18.6800	20.1100	21.6400	23.2900	24.8700

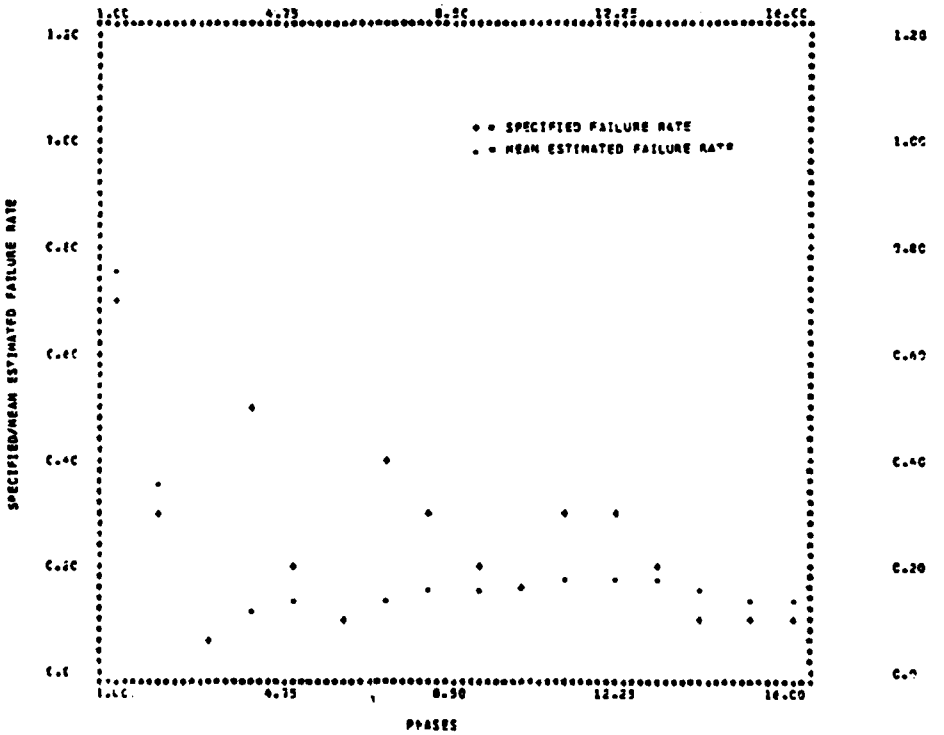


CASE 15

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.3000	0.0900	0.5000	0.2000	0.1000	0.4000	0.7000
PLANNED TEST TIME	0.2322	0.5417	3.2504	0.3250	0.6124	1.4252	0.4063	0.5417
MODEL ESTIMATE	0.7622	0.3512	0.0827	0.1195	0.1367	0.1045	0.1424	0.1673
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	8.89	17.05	25.32	76.02	31.66	4.54	64.19	44.22
SAMPLE STD DEVIATION	0.4269	0.1582	0.0377	0.2004	0.1081	0.0469	0.0840	0.0904
CUMULATIVE TEST TIME	4.272	14.288	74.066	80.098	99.034	124.611	133.344	142.278
CUMULATIVE FAILURES	2.9900	5.8500	9.0000	11.7600	14.8800	18.0500	21.3200	24.4500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.2000	0.1500	0.3000	0.3000	0.2000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.8124	1.0835	0.5417	0.5417	0.8124	1.4252	1.4252	1.6254
MODEL ESTIMATE	0.1692	0.1573	0.1769	0.1884	0.1869	0.1642	0.1475	0.1370
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	15.41	4.85	41.05	37.19	6.55	64.17	47.53	37.04
SAMPLE STD DEVIATION	0.0510	0.0650	0.0896	0.0883	0.0818	0.0454	0.0363	0.0320
CUMULATIVE TEST TIME	157.243	177.242	187.247	167.196	212.164	242.173	272.258	302.300
CUMULATIVE FAILURES	27.4000	30.4300	33.4100	36.6600	39.6100	42.6600	45.6900	48.6300

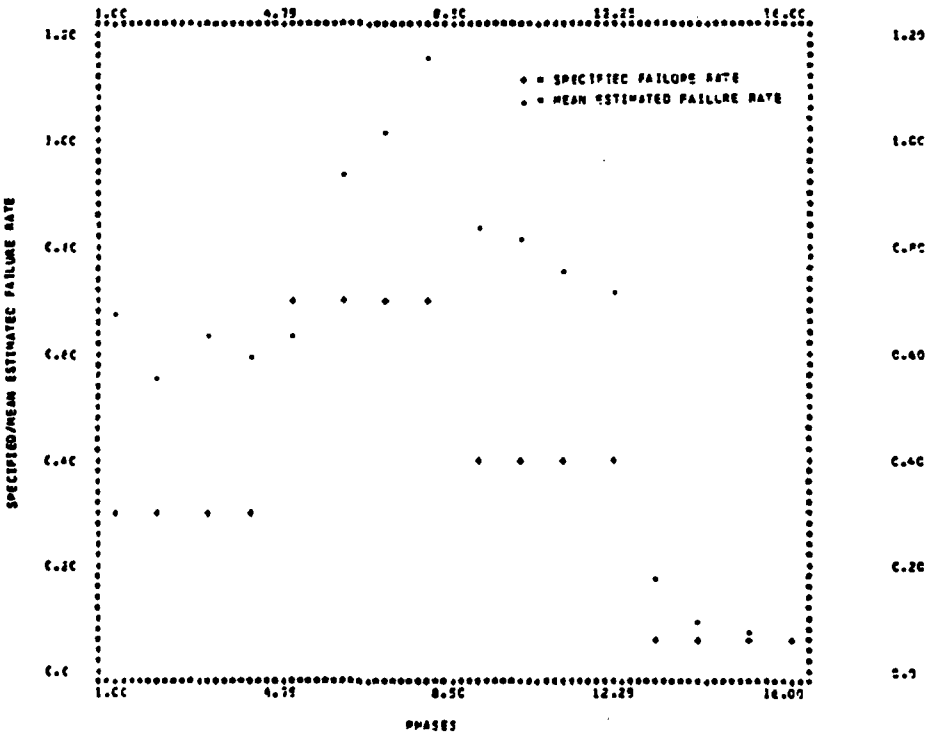


CASE 18

9 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	C.3CCC	0.3CCC	0.3CCC	C.3CCC	C.1CCC	0.1CCC	0.1CCC	0.1CCC
PLANNED TEST TIME	0.5417	0.5417	0.5417	C.5417	C.2322	C.2322	C.2322	0.2322
MODEL ESTIMATE	0.6856	0.5667	0.6452	C.5939	C.6396	0.6478	1.0787	1.1***
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	128.55	88.90	115.06	97.97	8.59	22.4C	44.56	65.64
SAMPLE STD DEVIATION	C.3824	0.3C11	0.3677	C.4844	C.7464	0.8715	0.7523	C.8695
CUMULATIVE TEST TIME	2.505	5.C42	7.587	1C.020	11.119	12.158	13.223	14.288
CUMULATIVE FAILURES	0.710C	1.42CC	2.2e0C	2.9000	3.42CC	4.47C0	5.03CC	5.51CC

PHASE	9	1C	11	12	13	14	15	16
ACTUAL FAILURE RATE	C.4CCC	0.4CC0	0.4CCC	C.4000	C.0500	C.C5CC	0.0500	0.C500
PLANNED TEST TIME	C.4C63	0.4C63	0.4C63	0.4063	3.25C4	3.25C4	3.25C4	3.25C4
MODEL ESTIMATE	0.8375	0.8294	0.7519	C.7293	0.1743	C.1CC5	0.0784	0.C6C4
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	1C9.37	107.36	87.98	80.82	248.68	1C1.C5	56.86	2C.87
SAMPLE STD DEVIATION	0.6796	0.66C4	0.6110	C.5380	C.1542	0.C499	0.0513	C.C282
CUMULATIVE TEST TIME	14.166	18.C57	19.641	21.804	26.765	51.57C	67.164	82.335
CUMULATIVE FAILURES	6.8200	7.52CC	8.27C0	8.9800	9.52CC	1C.48C0	11.2CCC	11.510C

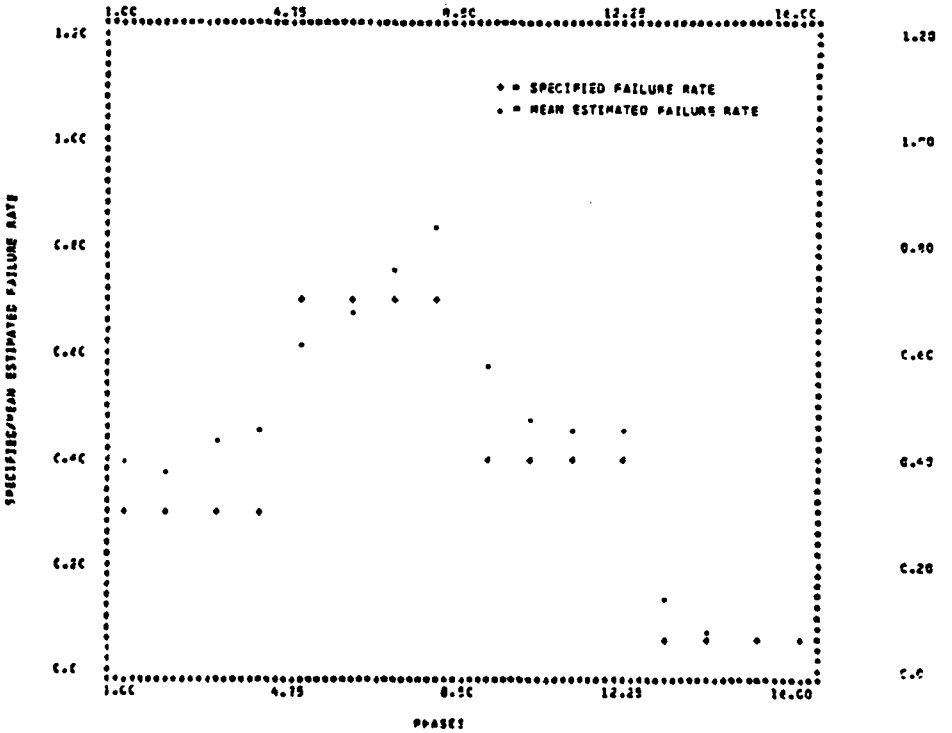


CASE 18

16 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.1000	0.1000	0.7000	0.7000
PLANNED TEST TIME	0.5417	0.5417	0.5417	0.5417	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	0.4691	0.3816	0.4460	0.4523	0.6225	0.6765	0.7695	0.6331
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	36.38	27.19	48.68	50.77	11.07	2.31	9.86	19.16
SAMPLE STD DEVIATION	0.2150	0.2124	0.3171	0.2569	0.4405	0.4153	0.5224	0.4772
CUMULATIVE TEST TIME	4.527	9.432	14.858	19.747	21.905	24.081	26.213	28.341
CUMULATIVE FAILURES	1.5900	3.0400	4.7600	6.5600	7.5700	9.1400	10.6800	12.4700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.5821	0.4701	0.4579	0.4509	0.1327	0.0862	0.0678	0.0588
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	45.54	17.53	14.48	12.74	165.48	72.45	35.66	17.67
SAMPLE STD DEVIATION	0.3305	0.1858	0.2051	0.2147	0.0628	0.0355	0.0283	0.0224
CUMULATIVE TEST TIME	32.125	35.950	39.705	43.456	73.610	103.736	133.755	163.586
CUMULATIVE FAILURES	13.8200	15.0400	16.5500	18.0700	19.4800	20.8400	22.2500	23.6700

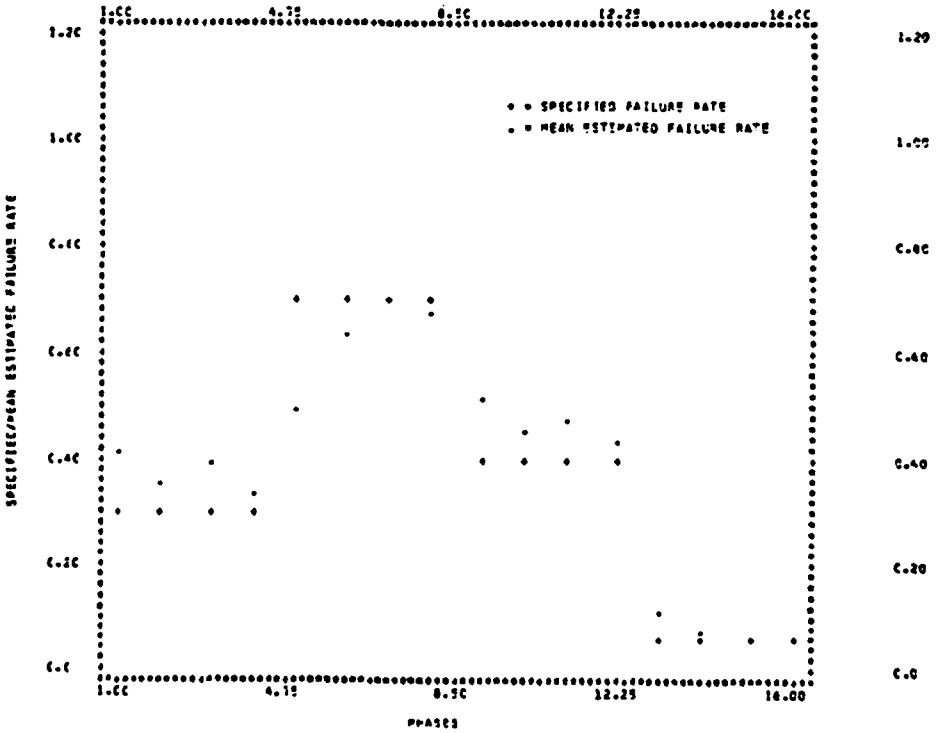


CASE 18

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.9417	0.9417	0.9417	0.9417	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	0.4185	0.3643	0.3617	0.3462	0.1536	0.1321	0.0994	0.0883
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	39.49	21.43	20.58	15.39	25.46	9.70	0.00	1.46
SAMPLE STD DEVIATION	0.2505	0.2188	0.2011	0.1819	0.2950	0.3163	0.2962	0.2926
CUMULATIVE TEST TIME	9.556	19.586	29.890	39.668	44.284	48.435	52.744	57.095
CUMULATIVE FAILURES	3.0000	5.9000	9.1000	12.0600	14.5400	16.1200	21.0300	23.4500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.5218	0.4624	0.4661	0.4394	0.1297	0.0794	0.0642	0.0553
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	30.44	15.60	21.53	9.86	159.33	58.85	28.34	10.51
SAMPLE STD DEVIATION	0.2717	0.2251	0.2259	0.1748	0.0792	0.0241	0.0242	0.0182
CUMULATIVE TEST TIME	64.569	72.651	79.547	87.097	147.563	208.336	267.736	327.622
CUMULATIVE FAILURES	26.9100	29.8600	33.1100	36.0300	38.5000	41.5400	44.6200	47.5000



APPENDIX F

Results of Test MOD4

1. Test MOD4

Test MOD4 used the AMSAA model to estimate the failure rate of the items tested except as described below. A more detailed discussion of the modification can be found in Section V-D.

Use of the AMSAA model was modified as follows:

a. The point estimate of the failure rate,

$$r_p = \frac{\text{number of failures during a phase}}{\text{total test time during a phase}} ,$$

was used whenever cumulative test time over all items was less than 10 hours.

b. The slope of the reliability growth pattern was estimated using the current point estimate, r_p, and the previous estimates of the failure rate, $\hat{r}_{i-1}$ and $\hat{r}_{i-2}$. The slope estimated was in two parts,

$$\hat{r}_{i-1} - \hat{r}_{i-2} \quad \text{and} \quad r_p - \hat{r}_{i-1} .$$

The estimate of the slope was considered increasing if both parts of the estimate were determined to be increasing as follows:

$$\hat{r}_{i-1} - \hat{r}_{i-2} \geq .2\hat{r}_{i-2}$$

and

$$r_p - \hat{r}_{i-1} \geq .2\hat{r}_{i-1} \quad .$$

If the slope was increasing, the point estimate, r_p, was used as the current estimate of the failure rate. Then, the AMSAA model was reinitialized, that is, time and failures prior to an increasing slope were not considered in future estimates made by the model.

2. The Results

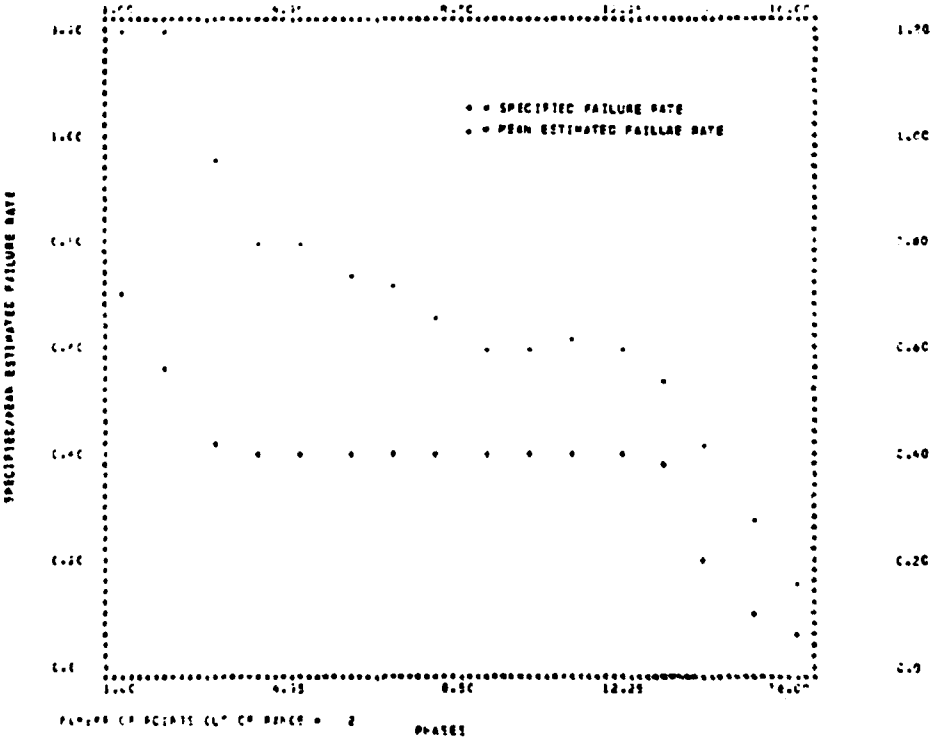
Results for Cases 4, 6, 15, and 18 are presented here as representative of the effect the modifications had on the performance of the model. A detailed description of the format of the results can be found in Appendix A.

CASE 4

9 STEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	C.3CCC	0.5CC0	0.4250	C.4C5C	C.4CCC	C.4CC0	C.4CC0	0.4000
EXPECTED TEST TIME	0.2322	0.2559	0.3824	C.4017	C.4C63	C.4C62	0.4263	C.4C63
MODEL ESTIMATE	1.3264	1.3186	C.9675	C.8075	C.6C67	0.544C	C.7156	C.6558
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	85.46	139.74	127.64	99.37	1C1.68	86.C1	76.85	63.96
SAMPLE STD DEVIATION	C.6578	0.7415	C.6549	C.4593	C.4C55	0.4834	0.5557	C.4663
CUMULATIVE TEST TIME	1.C74	2.418	4.202	6.C45	7.942	9.842	11.697	13.580
CUMULATIVE FAILURES	C.64CC	1.42CC	2.0500	3.0900	3.99CC	4.82CC	5.64CC	6.37CC

PHASE	9	1C	11	12	13	14	15	16
ACTUAL FAILURE RATE	C.4CCC	0.4CC0	0.4000	C.4000	0.375C	0.2CCC	C.1CC0	0.0500
EXPECTED TEST TIME	C.4C63	0.4C63	0.4C63	C.4C63	C.4334	C.8126	1.4252	3.2504
MODEL ESTIMATE	C.6C16	0.6C15	0.6177	C.5977	C.5446	C.412C	C.2700	0.1532
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	50.41	5C.37	54.43	49.43	45.24	1CC.C1	17C.C1	2C6.4C
SAMPLE STD DEVIATION	0.3664	0.3563	C.3634	C.3770	C.3466	C.2573	C.2C77	C.1437
CUMULATIVE TEST TIME	15.442	17.315	19.188	21.C45	22.C79	24.CCC	24.926	49.9C4
CUMULATIVE FAILURES	6.5800	7.3CC3	8.0CCC	8.6900	9.23CC	1C.C1CC	1C.8CC0	1?.64CC

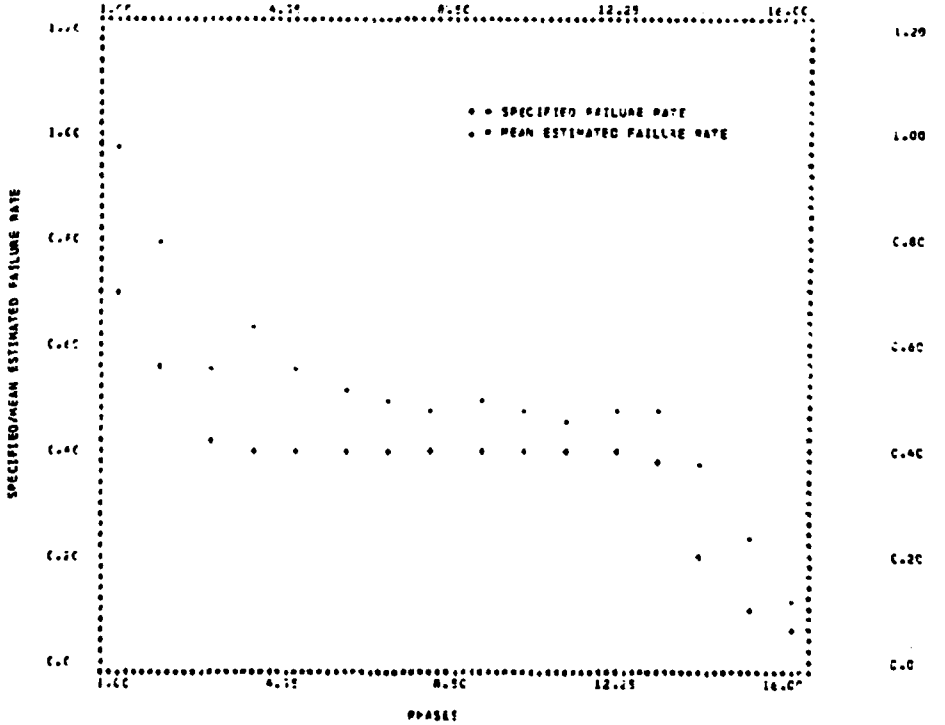


CASE 4

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.5000	0.4250	0.4050	0.4000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2222	0.2555	0.3624	0.4013	0.4063	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.9736	0.7546	0.5631	0.6317	0.5626	0.5103	0.4937	0.4734
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	36.13	44.48	32.50	55.51	40.65	27.59	23.43	18.35
SAMPLE STD DEVIATION	0.6085	0.5476	0.3305	0.6257	0.4215	0.3326	0.3259	0.2306
CUMULATIVE TEST TIME	2.136	4.667	8.462	12.139	15.883	19.633	23.410	27.795
CUMULATIVE FAILURES	1.5400	2.8500	4.1100	5.9000	7.3100	8.6400	10.1000	11.2700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.3750	0.2000	0.1000	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	0.4234	0.8126	1.6252	3.2504
MODEL ESTIMATE	0.4554	0.4719	0.4693	0.4749	0.4861	0.3763	0.2360	0.1288
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	23.85	17.97	17.33	18.74	29.64	88.13	135.98	157.69
SAMPLE STD DEVIATION	0.2732	0.2569	0.2628	0.2450	0.2440	0.2103	0.1032	0.0447
CUMULATIVE TEST TIME	30.543	34.723	38.459	42.187	46.178	53.627	68.585	98.351
CUMULATIVE FAILURES	13.0700	14.4500	16.0100	17.5700	19.1600	20.8000	22.3600	23.9300

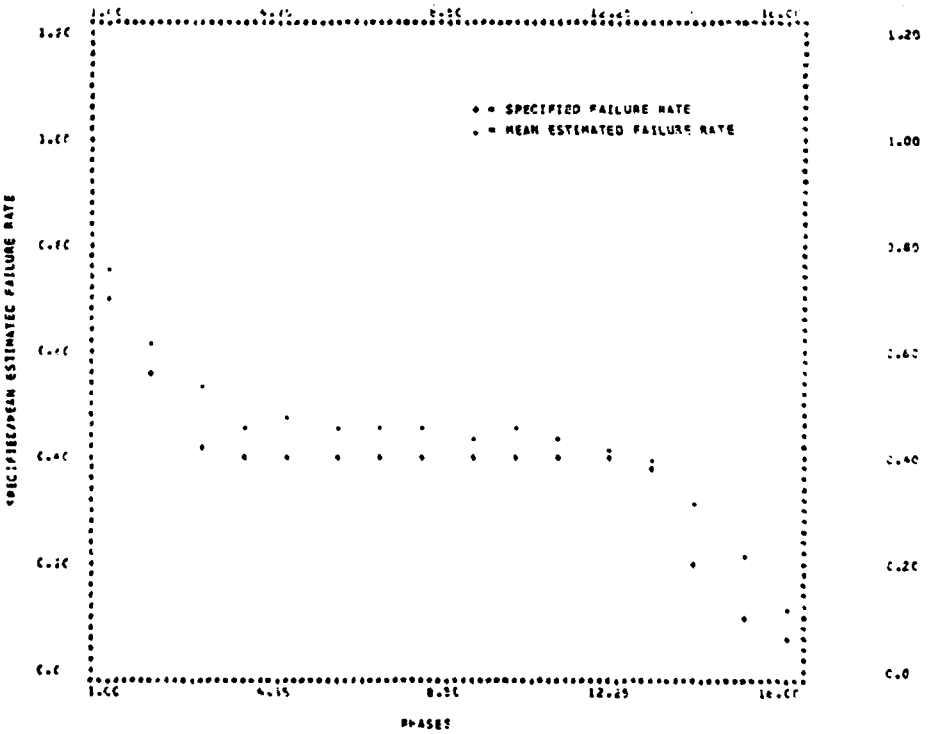


CASE 4

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7030	0.5500	0.4250	0.4050	0.4000	0.4000	0.4000	0.4000
ELAPSED TEST TIME	0.2322	0.2659	0.3624	0.4013	0.4063	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.7578	0.6134	0.5322	0.4618	0.4705	0.4524	0.4506	0.4497
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	8.23	11.52	25.22	14.02	17.63	13.09	12.64	12.16
SAMPLE STD DEVIATION	0.4180	0.3452	0.3033	0.2545	0.2521	0.2209	0.1825	0.1866
CUMULATIVE TEST TIME	4.313	9.758	16.674	24.303	31.758	39.327	46.755	54.188
CUMULATIVE FAILURES	2.9500	5.8600	8.8700	11.7100	14.7100	17.7400	20.8300	24.0700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.3750	0.2000	0.1000	0.0500
ELAPSED TEST TIME	0.4063	0.4063	0.4063	0.4063	0.4334	0.8126	1.6252	3.2504
MODEL ESTIMATE	0.4376	0.4304	0.4331	0.4219	0.4086	0.3268	0.2192	0.1282
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	9.40	12.59	8.28	5.47	9.03	64.41	119.21	156.49
SAMPLE STD DEVIATION	0.1478	0.1569	0.1384	0.1205	0.1133	0.0867	0.0648	0.0387
CUMULATIVE TEST TIME	61.676	69.133	76.672	84.172	92.154	107.154	131.320	157.432
CUMULATIVE FAILURES	27.0400	30.2200	33.2300	36.1700	39.0600	42.0600	44.6000	47.6000

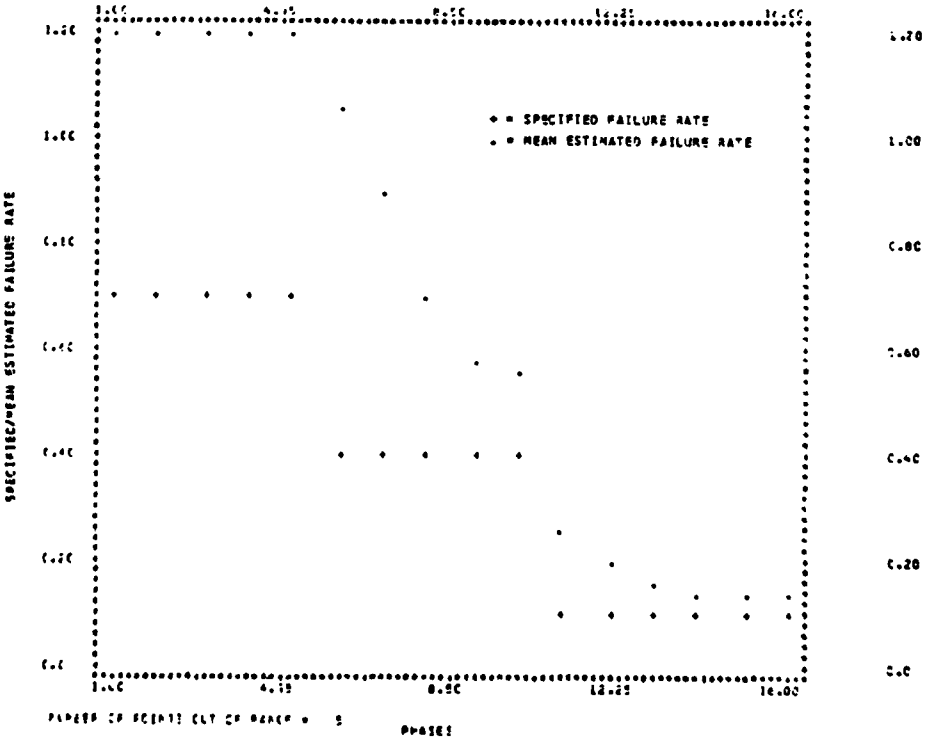


CASE 6

8 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.1000	0.7000	0.1000	0.1000	0.4000	0.4000	0.4000
PLANNED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.4063	0.4063	0.4063
MODEL ESTIMATE	1.3652	1.4565	1.3739	1.4042	1.3352	1.0660	0.5046	0.7039
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	95.03	100.26	96.28	100.61	90.74	166.51	126.16	75.98
SAMPLE STD DEVIATION	0.6434	0.8648	0.7531	0.7801	0.6851	0.7149	0.6319	0.4647
CUMULATIVE TEST TIME	1.061	2.128	3.209	4.305	5.374	7.210	9.075	10.566
CUMULATIVE FAILURES	0.7400	1.4100	2.1100	2.8400	3.5500	4.4600	5.1800	6.0100

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.4063	0.4063	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.5670	0.5612	0.2547	0.1974	0.1613	0.1387	0.1356	0.1407
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	46.75	40.30	154.71	97.37	61.33	38.75	35.65	40.72
SAMPLE STD DEVIATION	0.3553	0.4326	0.1452	0.1285	0.0885	0.0777	0.0821	0.1032
CUMULATIVE TEST TIME	12.856	14.742	22.241	25.772	31.201	44.676	52.044	55.522
CUMULATIVE FAILURES	6.6800	7.3800	7.9800	8.5000	9.7000	10.4000	11.3000	12.1500



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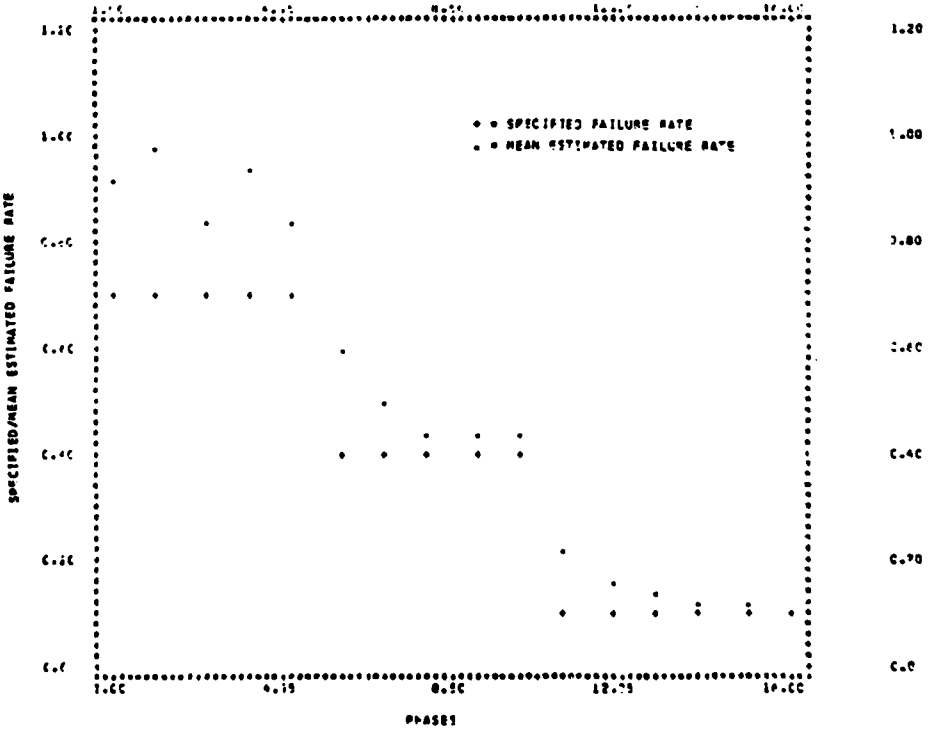
CASE 6

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.7000	0.7000	0.7000	0.7000	0.4000	0.4000	0.4000
ELAPSED TEST TIME	0.2322	0.2322	0.2322	0.2322	0.2322	0.4063	0.4063	0.4063
MODEL ESTIMATE	0.9162	0.6703	0.8404	0.6337	0.8485	0.5553	0.5030	0.4403
ESTIMATE BIAS AS PERCENTAGE OF ACTUAL FAILURE RATE	31.32	98.63	20.05	33.38	21.21	48.82	25.76	10.07
SAMPLE STD DEVIATION	0.5079	0.5632	0.4066	0.4941	0.4528	0.3527	0.2424	0.2120
CUMULATIVE TEST TIME	2.158	4.277	6.441	8.559	10.726	14.496	18.267	22.093
CUMULATIVE FAILURES	1.3600	2.9500	4.3100	5.9200	7.1800	8.4800	9.6800	11.2800

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
ELAPSED TEST TIME	0.4063	0.4063	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.4457	0.4308	0.2285	0.1644	0.1431	0.1246	0.1155	0.1098
ESTIMATE BIAS AS PERCENTAGE OF ACTUAL FAILURE RATE	12.42	7.71	128.46	64.57	43.12	24.61	15.51	9.77
SAMPLE STD DEVIATION	0.2474	0.1931	0.1026	0.0577	0.0493	0.0446	0.0360	0.0331
CUMULATIVE TEST TIME	25.831	29.565	44.552	55.418	74.438	85.320	104.331	115.206
CUMULATIVE FAILURES	12.7500	14.1500	15.7600	17.4500	19.0200	20.5800	22.1800	23.7400

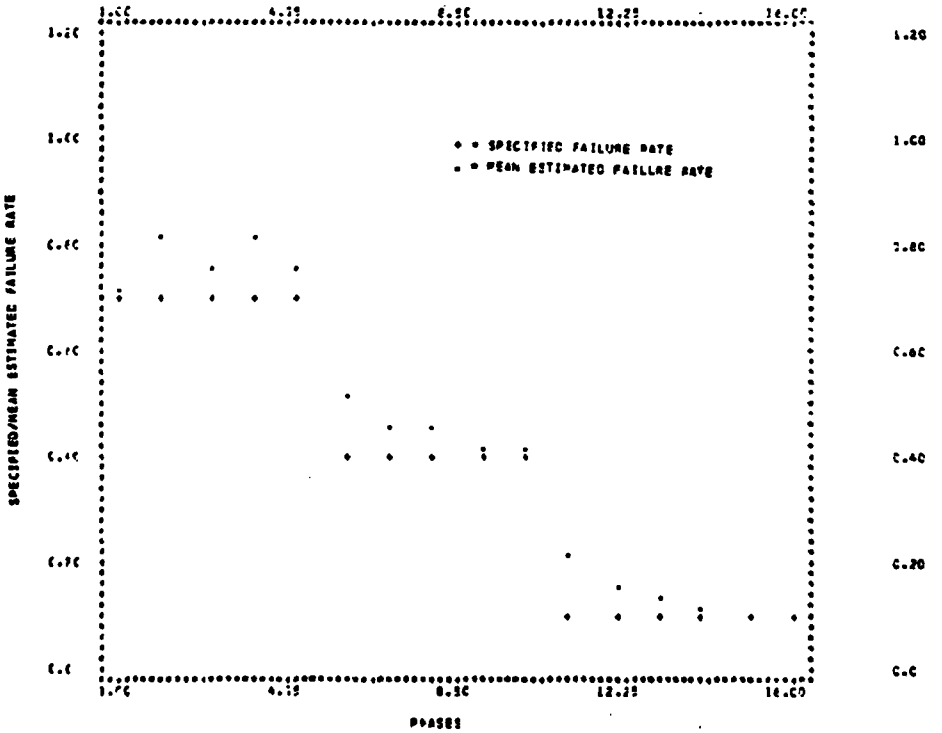


CASE 6

20 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	C.7CCC	C.7CCC	C.7CCC	C.7CCC	C.7CCC	C.4CCC	C.4CCC	C.4CCC
PLANNED TEST TIME	C.2322	C.2322	C.2322	C.2322	C.2322	C.4C63	C.4C63	C.4C63
ACCEL ESTIMATE	C.7251	C.8171	C.7619	C.8146	C.7083	C.5247	C.4575	C.4586
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	3.58	16.72	8.84	16.37	1.76	31.18	14.48	14.64
SAMPLE STD DEVIATION	C.4C87	C.4C78	C.4044	C.4183	C.3747	C.2256	C.1644	C.1675
CUMULATIVE TEST TIME	4.264	8.581	12.842	17.130	21.415	26.465	30.41C	43.831
CUMULATIVE FAILURES	2.71CC	6.0CC0	9.2000	12.3000	15.21C0	18.87CC	21.C2C0	24.1CCC

PHASE	9	1C	11	12	13	14	15	16
ACTUAL FAILURE RATE	C.4CCC	C.4CCC	C.1CC0	C.1CCC	C.1CCC	C.1CC0	C.1CC0	C.1CCC
PLANNED TEST TIME	C.4C63	C.4C63	1.6252	1.6252	1.6252	1.6252	1.6252	1.6252
ACCEL ESTIMATE	C.4145	C.4227	C.2133	C.1596	C.1348	C.1176	C.1C75	C.1C09
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	3.73	5.69	113.29	59.63	34.83	17.58	7.56	C.9C
SAMPLE STD DEVIATION	C.1444	C.1487	C.0866	C.C491	C.C374	C.C322	C.C267	C.C219
CUMULATIVE TEST TIME	51.373	58.656	66.818	118.487	148.459	178.519	206.549	238.037
CUMULATIVE FAILURES	27.C2CC	3C.C4CC	33.1700	36.4600	39.4300	42.3CCC	45.2600	48.2200

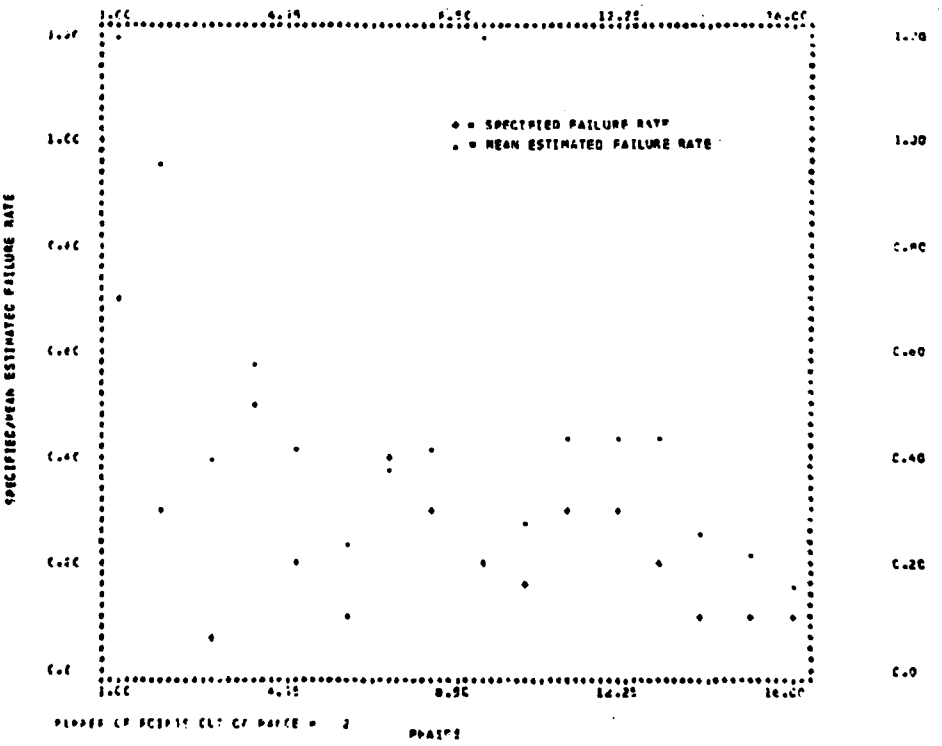


CASE 15

8 STEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.3000	0.0900	0.5000	0.2000	0.1000	0.4000	0.3000
CLAPPER TEST TIME	0.2222	0.5417	3.2504	0.3250	0.8126	1.6252	0.4062	0.5417
ACCEL ESTIMATE	1.5230	0.9658	0.4066	0.9736	0.4183	0.2461	0.3830	0.4372
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	117.57	223.26	713.18	14.72	109.13	146.19	2.29	45.41
SAMPLE STD DEVIATION	1.0053	0.8302	0.8305	0.4133	0.4054	0.2845	0.4882	0.2911
CUMULATIVE TEST TIME	1.074	3.573	18.481	19.990	23.722	33.228	33.112	33.575
CUMULATIVE FAILURES	0.7000	1.4000	2.1400	2.9300	3.4900	4.4200	5.0500	5.6700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.2000	0.1000	0.3000	0.3000	0.2000	0.1000	0.1000	0.1000
CLAPPER TEST TIME	0.8126	1.6252	0.5417	0.5417	0.8126	1.6252	1.6252	1.6252
ACCEL ESTIMATE	2.3176	0.2756	0.4459	0.4493	0.4311	0.2684	0.2146	0.1664
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	1068.78	83.72	48.63	47.76	115.55	168.38	114.63	66.66
SAMPLE STD DEVIATION	15.7494	0.2310	0.6855	0.2964	0.3810	0.2279	0.2007	0.1181
CUMULATIVE TEST TIME	39.351	44.288	46.786	49.254	53.305	60.484	68.057	75.729
CUMULATIVE FAILURES	6.3500	7.4500	8.3100	9.1000	9.8100	10.5100	11.3500	11.4500

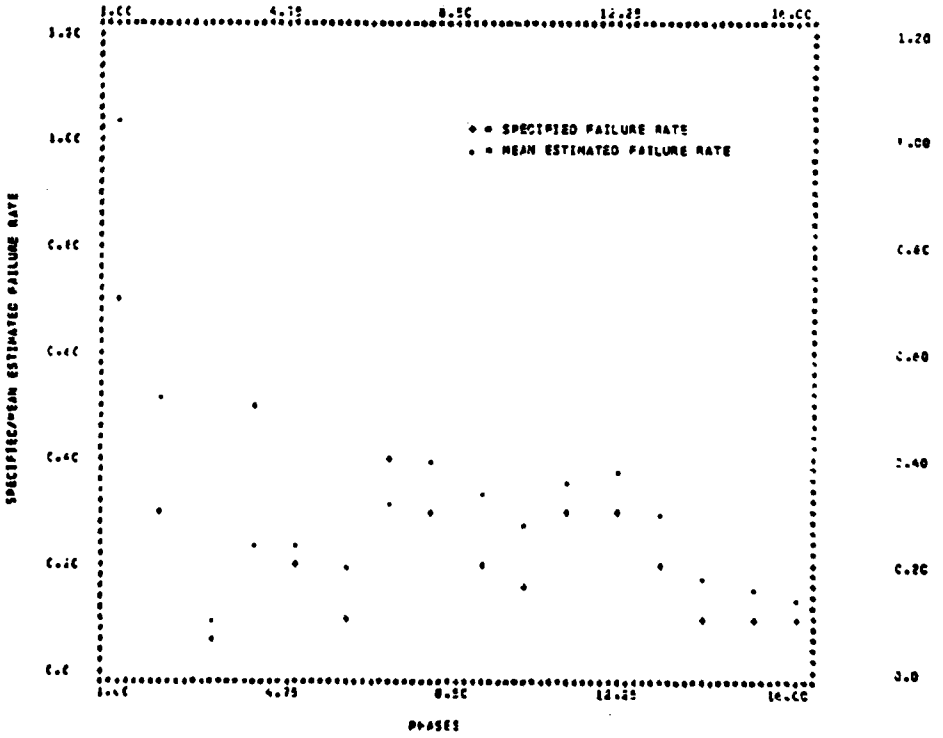


CASE 15

10 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.3000	0.0500	0.5000	0.2000	0.1000	0.4000	0.3000
PLANNED TEST TIME	0.2333	0.5417	3.2504	0.3250	0.8126	1.6252	0.4063	0.5417
MODEL ESTIMATE	1.0352	0.5182	0.0697	0.2490	0.2391	0.1600	0.3284	0.4017
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	48.46	72.74	95.36	50.20	19.53	60.02	17.89	33.90
SAMPLE STD DEVIATION	0.5388	0.3643	0.1958	0.3090	0.2030	0.1356	0.2563	0.2972
CUMULATIVE TEST TIME	2.104	7.083	37.101	40.105	47.626	69.576	66.304	71.762
CUMULATIVE FAILURES	1.7700	3.2400	4.8500	6.3000	7.5200	9.3600	10.5600	12.9500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.2000	0.1000	0.3000	0.3000	0.2000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.8126	1.6252	0.5417	0.5417	0.8126	1.6252	1.6252	1.6252
MODEL ESTIMATE	0.2430	0.2760	0.3541	0.3716	0.2520	0.1863	0.1548	0.1416
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	71.52	84.03	18.03	23.99	46.01	86.28	54.77	41.52
SAMPLE STD DEVIATION	0.3097	0.2157	0.3028	0.2882	0.2416	0.0580	0.0762	0.0831
CUMULATIVE TEST TIME	78.788	88.725	93.707	98.702	106.246	121.305	136.257	151.192
CUMULATIVE FAILURES	13.0300	15.4000	17.1800	18.6800	20.1100	21.4200	23.2500	24.8700

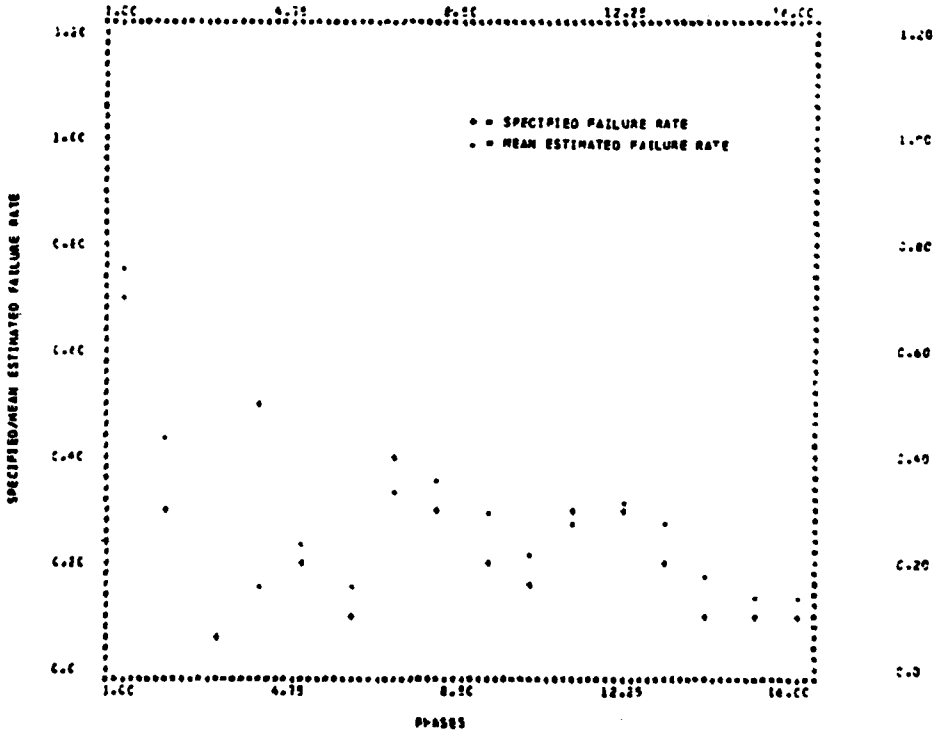


CASE 15

20 TYPE?

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.7000	0.3000	0.0500	0.5000	0.2000	0.1000	0.4000	0.2500
PLANNED TEST TIME	0.2222	0.5417	3.2504	0.3250	0.8126	1.6252	0.4063	0.5417
PCOBL ESTIMATE	0.1622	0.4386	0.3605	0.1631	0.2373	0.1614	0.2924	0.2649
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	8.65	46.15	20.58	67.39	18.66	61.36	36.65	21.44
SAMPLE STD DEVIATION	0.4205	0.3152	0.0256	0.2237	0.1373	0.1056	0.3656	0.1631
CUMULATIVE TEST TIME	4.272	14.268	74.066	80.098	99.034	124.511	136.246	142.278
CUMULATIVE FAILURES	2.9500	5.8100	9.0000	11.7600	14.8800	18.0500	21.3200	24.4500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.2000	0.1500	0.3000	0.3000	0.2000	0.1000	0.1000	0.1000
PLANNED TEST TIME	0.8126	1.0855	0.5417	0.5417	0.8126	1.6252	1.6252	1.6252
PCOBL ESTIMATE	0.2551	0.2206	0.2749	0.3298	0.2730	0.1352	0.1454	0.1323
ESTIMATE BASED AS PERCENTAGE OF ACTUAL FAILURE RATE	47.99	47.05	8.37	9.93	36.52	35.21	45.38	32.26
SAMPLE STD DEVIATION	0.1478	0.1087	0.1547	0.2071	0.1417	0.0763	0.0588	0.0471
CUMULATIVE TEST TIME	157.243	177.242	187.247	197.196	212.154	242.173	272.258	302.306
CUMULATIVE FAILURES	27.4500	30.4300	33.6100	36.6600	39.6100	42.6600	45.4500	48.4300

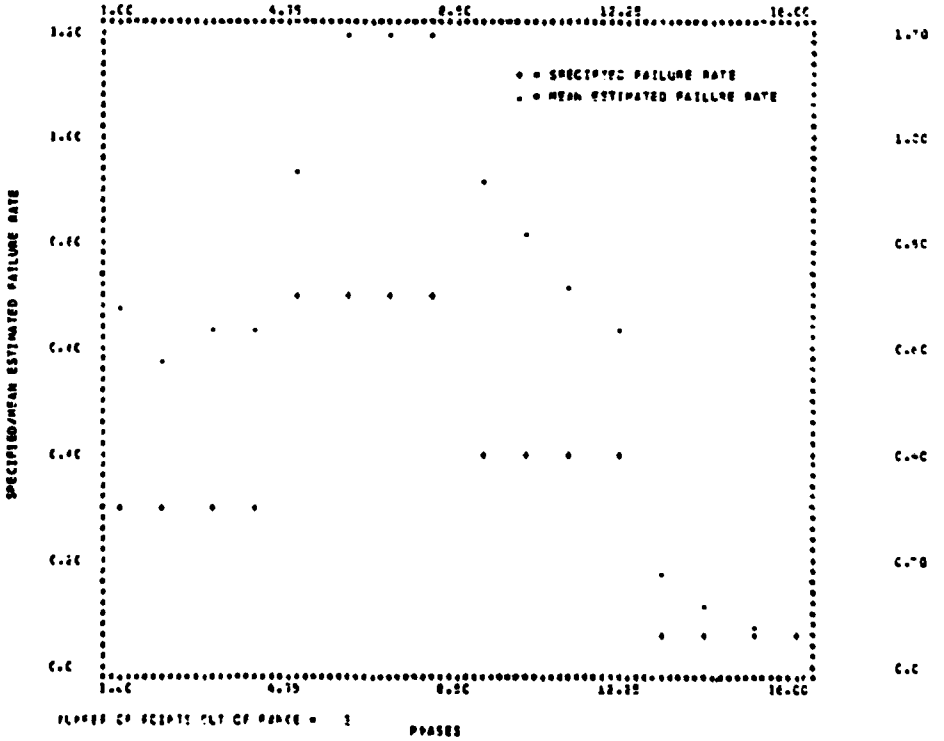


CASE 10

5 ITEMS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3CCC	0.3CCC	0.3CCC	0.3000	0.1CCC	0.1CCC	0.1CCC	0.1CCC
PLANNED TEST TIME	0.5417	0.5417	0.5417	0.5417	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	0.6856	0.5755	0.6478	0.6385	0.4378	1.2271	1.2C28	1.2272
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	128.53	91.84	115.93	112.83	33.83	36.73	71.82	76.76
SAMPLE STD DEVIATION	0.3624	0.3C68	0.3614	0.3628	0.6532	0.66CC	0.8665	0.8507
CUMULATIVE TEST TIME	2.509	5.042	7.5C7	10.020	11.115	12.150	13.223	14.288
CUMULATIVE FAILURES	0.71CC	1.33C0	2.1800	2.8300	3.4000	4.35CC	5.13CC	6.0P3C

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4CCC	0.4CC0	0.4CC0	0.4300	0.C5CC	0.C5CC	0.05C0	0.C*CC
PLANNED TEST TIME	0.4C63	0.4C63	0.4C63	0.4C63	3.2504	3.25C4	3.25C4	3.25C4
MODEL ESTIMATE	0.9224	0.8152	0.7253	0.6333	0.1755	0.1122	0.C762	0.C673
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	130.59	103.8C	81.33	58.33	255.C6	124.64	56.41	34.6C
SAMPLE STD DEVIATION	0.8110	0.5279	0.5256	0.374C	0.C858	0.C451	0.C324	0.C*59
CUMULATIVE TEST TIME	14.166	18.C57	15.541	21.004	26.765	31.57C	41.164	82.955
CUMULATIVE FAILURES	6.78CC	7.55C0	8.27C0	8.97CC	9.8100	10.4CCC	11.2CC0	11.6*0C

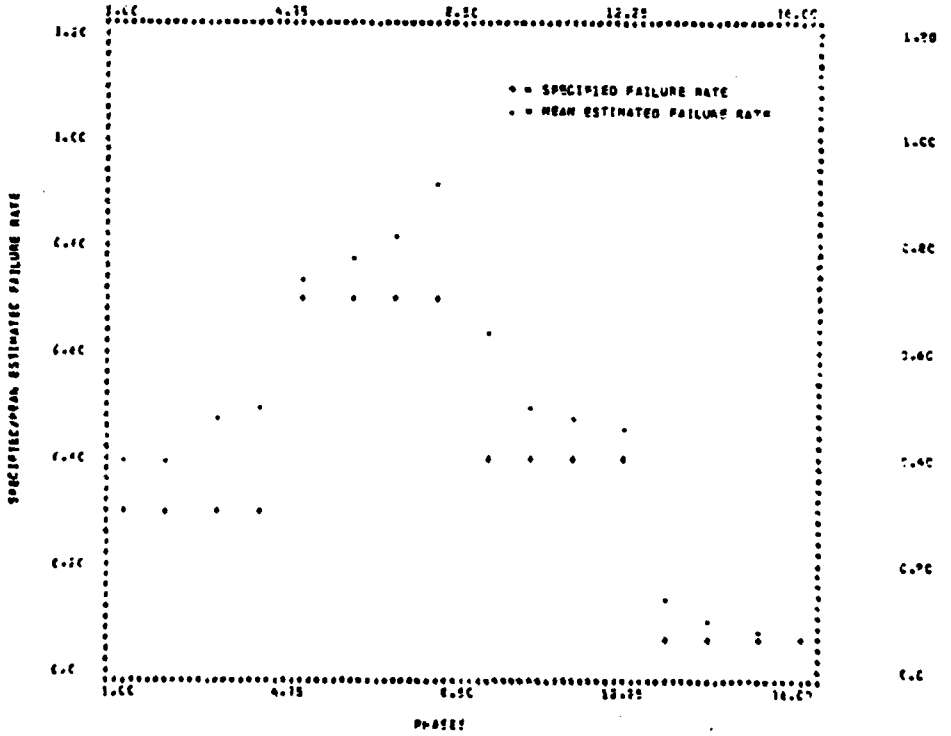


CASE 18

18 STEPS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
PLANNED TEST TIME	0.5417	0.5417	0.5417	0.5417	0.2222	0.2222	0.2222	0.2222
MODEL ESTIMATE	0.4051	0.3541	0.4055	0.4051	0.3464	0.3703	0.3273	0.3147
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	36.38	31.37	63.17	65.02	6.78	10.04	17.47	30.47
SAMPLE STD DEVIATION	0.2190	0.2343	0.3784	0.2533	0.2528	0.4665	0.4535	0.5060
CUMULATIVE TEST TIME	4.927	9.432	14.858	19.747	21.909	24.061	26.213	28.341
CUMULATIVE FAILURES	1.5000	2.6700	4.7300	6.5600	7.6700	9.1400	10.8400	12.4700

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.0500	0.0500	0.0500	0.0500
PLANNED TEST TIME	0.4063	0.4063	0.4063	0.4063	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.6387	0.4585	0.4821	0.4680	0.1410	0.0545	0.0755	0.0616
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	59.67	24.63	20.53	16.99	154.08	8.98	51.02	23.19
SAMPLE STD DEVIATION	0.3413	0.2025	0.2364	0.1534	0.0787	0.0433	0.0565	0.0276
CUMULATIVE TEST TIME	32.125	35.590	35.703	43.459	77.615	102.736	121.155	149.586
CUMULATIVE FAILURES	13.4200	15.0600	16.5500	18.0700	25.4800	26.8400	32.3300	39.8700

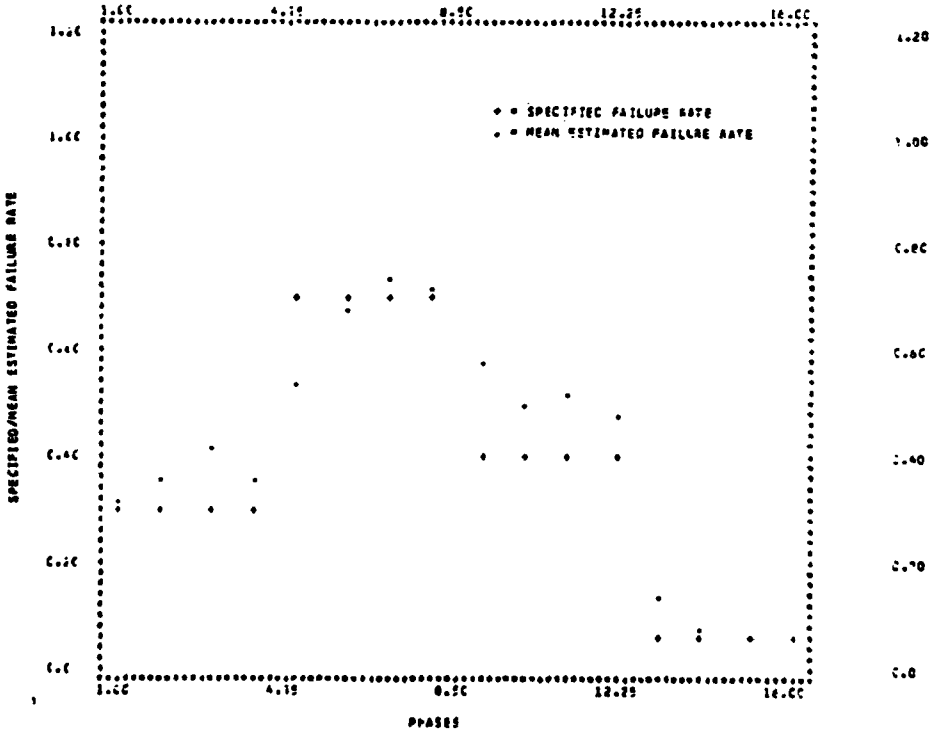


CASE 18

20 TRIALS

PHASE	1	2	3	4	5	6	7	8
ACTUAL FAILURE RATE	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
BINOMIAL TEST TIME	0.5417	0.5417	0.5417	0.5417	0.2322	0.2322	0.2322	0.2322
MODEL ESTIMATE	0.3215	0.3610	0.4102	0.3591	0.5376	0.6789	0.7301	0.7270
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	7.16	20.34	36.75	19.71	79.21	126.32	143.36	142.34
SAMPLE STD DEVIATION	0.1815	0.2147	0.3270	0.1976	0.2854	0.2245	0.4018	0.2486
CUMULATIVE TEST TIME	9.454	19.586	29.850	39.508	44.262	48.432	52.144	57.035
CUMULATIVE FAILURES	3.3300	5.6000	9.1600	12.0600	14.4100	18.1200	21.0200	23.5500

PHASE	9	10	11	12	13	14	15	16
ACTUAL FAILURE RATE	0.4000	0.4000	0.4000	0.4000	0.0500	0.0500	0.0500	0.0500
BINOMIAL TEST TIME	0.4083	0.4083	0.4083	0.4083	3.2504	3.2504	3.2504	3.2504
MODEL ESTIMATE	0.5736	0.5011	0.5129	0.4748	0.1374	0.0874	0.0649	0.0587
ESTIMATE ERROR AS PERCENTAGE OF ACTUAL FAILURE RATE	43.44	25.28	28.22	18.70	174.86	74.82	29.84	17.42
SAMPLE STD DEVIATION	0.2710	0.2315	0.2284	0.1613	0.0597	0.0360	0.0251	0.0166
CUMULATIVE TEST TIME	64.565	72.651	76.567	87.097	147.563	208.236	267.726	327.822
CUMULATIVE FAILURES	26.3100	29.8600	33.1100	36.0300	38.5000	41.5400	44.6200	47.5000



LIST OF REFERENCES

1. Military Handbook for Reliability Growth Management, Proposed MIL-HDBK-XXX, 7 July 1978.

2. Crow, L. H., 1975, "On Tracking Reliability Growth", Proceedings 1975 Annual Reliability and Maintainability Symposium.

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